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ORAL CHOLECYSTOGRAPHY¹

THE BASIS OF STANDARDIZATION OF THE METHOD

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It affords me much pleasure to contribute another chapter in commemoration of the discovery and development of cholecystography by Graham and his associates. It is a time-worn subject, yet it is one which has placed at our disposal a method which has improved the diagnostics of gall-bladder disease, and which should be more intensively studied, that the technic of its application may become standardized, and the results obtained more uniformly reliable.

Lewis Gregory Cole has said that functional changes in the gall bladder are synonymous with pathologic conditions. Yet, in order to interpret pathology in terms of functional changes, a uniform and dependable technic becomes imperative. This must be especially stressed in the oral method, which is far more extensively employed than the intravenous; yet, it is lamentable what a lack of standardization exists in conducting these examinations. As a result of this diverse and imperfect application of the method, and recollections of the difficulties encountered in the experimental period, it

has been assumed by many advocates of the method that it is less accurate than the intravenous.

Beilin and Carlson (17) report an accuracy of 98.3 per cent by the oral method in a study of 750 cases. This is based on positive diagnoses confirmed or negated by operative findings. Kirklin (15), in a census of 35,000 cholecystographic examinations by this method at the Mayo Clinic, shows that the diagnostic results, taking into account all errors both positive and negative, are slightly above 90 per cent correct. He shows that the greatest ratio of error occurs in that group of cases in which the response to the test is reported normal, yet the gall bladder is to be found grossly diseased at operation. This negative error is approximately 15 per cent, and will probably be included in the general average of correct diagnoses in any clinic where cases are operated upon on the basis of clinical symptoms in spite of the cholecystographic findings. In a study of 2,235 cases examined by the oral method in the Crisler Clinic, the diagnostic results have been 97.3 per cent correct. This series of cases includes 27 which were reported normal by the test, yet which were operated upon on the basis of clinical symptomatology. In other words, the

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average of correct diagnoses is practically identical with that reported by those using the intravenous technic in the larger

as well as reduce the negative error in these examinations to a minimum. In our experience, it has never been found neces-

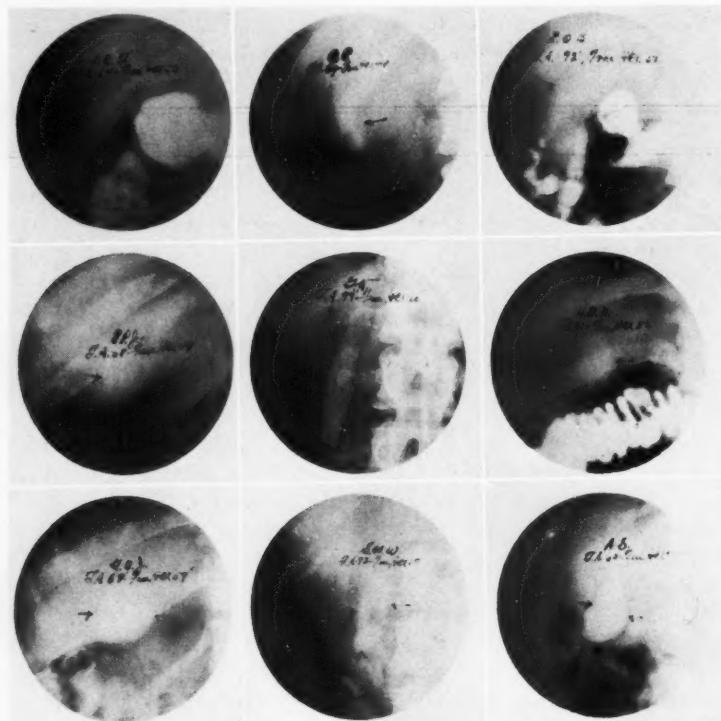


Fig. 1. Representative cholecystograms from a series of 200 cases of hyperchlorhydria. The old technic was used, 4 gm. tetradol emulsion being given immediately after fat-free meal, no alkali given. Note the poor concentration of the dye, although all of these were normal gall bladders.

institutions. In many of the larger clinics, because of the fact that any increase in concentration of the dye by the intravenous method did not occur in as much as 1 per cent of the cases, this more laborious method, with its possible dangers to the patient, has been discarded. It is the purpose of this paper to discuss and record the essentials of a rational and carefully planned oral method of administration, founded on the recognition of known fundamental principles, which will produce satisfactory cholecystograms in as short a period of time as may be consistent with thoroughness, and yet give a high percentage of operative confirmation

necessary to resort to the more time-consuming methods such as the intensive technic described by Stewart and Illick (21).

Since cholecystography is primarily an index of the functional activity of the gall bladder and its ducts, any dependable method used to visualize the organ, whether the dye be given orally or intravenously, must be based upon the strict observance of this physiology. The gall bladder must fill, concentrate, change in size, and empty to constitute a normal cycle. These factors are dependent, respectively, upon, first, a closed sphincter of Oddi, second, a normal gall-bladder mucosa, and third, contractility of the

intrinsic musculature of the gall-bladder wall. These shall be discussed in the order named.

1. *Function of Sphincter of Oddi.*—As filling is a passive process, secondary to stasis of bile in the biliary tract, it is desirable that the sphincter choledochus remain contracted during the starvation period in order that the normal intrabiliary pressure be maintained, permitting a maximum volume of the dye-laden bile to enter the gall bladder. Chemical substances, such as acetyl-choline, alkalies, and physostigmine, which excite the parasympathetic nervous system, increase the tonus of the choledochoduodenal mechanism. This action of acetyl-choline has been demonstrated both *in vivo* and *in vitro* by Kitakoji (13) and confirmed by Shi (20). The drug has been used by us in doses of from 100 to 200 mg., given in capsule one hour after the dye, and found to be effective, but was discontinued, due to the fact that it also increases the tone of the whole gastro-intestinal tract, with resultant diarrhea. Physostigmine has a similar effect. The investigations of Butsch (23) and others show that derivatives of opium, such as codeine, dilaudid, and pantopon, and especially morphine sulphate in an effective dose of 1/6 grain given hypodermically, have a pronounced and prolonged effect on the sphincter, producing spasmodic constriction of this and an increase of intrabiliary pressure to 300 mm. of water. While this effect is distinctly advantageous in cholangiography, it is most objectionable in cholecystography, as the increased intraductal pressure suppresses the flow of contrast bile from the liver, distends the gall bladder, and inhibits any contractile response of the latter to a fat meal. Due to spasm of the pyloric sphincter of the stomach (morphine excites spasm of all sphincters) it may also be possible that the fat meal cannot enter the duodenum in sufficient quantity to induce contraction of the gall bladder. Sussman (26) has also made these observations. Any of these opiates used in a dosage necessary to keep the sphincter of

Oddi closed during the period of observation of the gall bladder would interfere very materially with the co-operation of the patient in the examination.

Sustained closure of the sphincter of Oddi is best accomplished by the rationale of maintained alkalization of the stomach or duodenum, which increases the tone of the muscle, producing tonic contraction of its fibers. The experiments of Warren H. Cole (2) show that in dogs the flow of bile into the intestine, through relaxation of the sphincter, is prevented by alkalizing either the stomach or duodenal contents. While dilute hydrochloric acid applied to the mucosa of the stomach or duodenum almost invariably induces loss of resistance, with opening of the sphincter, very weak solutions of bicarbonate of soda or sodium hydroxide produce increased tone of its musculature, accompanied by closure. These observations were confirmed by the work of Elman and McMaster (4), and by Giordano and Mann (5).

For some time prior to the use of gastric alkalization in our routine cholecystography by the oral method (1929), it was noted that gastric sub-acidity, provided the gall bladder was not diseased, directly increased the cholecystographic response, and if an achlorhydria was present, some of the best cholecystograms were obtained. Reference to the literature revealed that Hines (10) had observed that achylia gastrica interfered with the visualization of the gall bladder. He reported three cases of absence of shadow, in which the dye was given intravenously. However, the histories of the three cases reported indicated that the patients probably had cholecystitis, and none of them was operated upon. In answer to this article, Davis and Talley (11) contradicted Hines' conclusions by showing that in 20 cases of achlorhydria, 15 of which had been tested with histamine, absorption of dye by the oral method in capsule, preceded by a fat-free meal, was excellent, and half of the cases showed normal shadows. They further observed that their cholecysto-

graphic and operative findings were remarkably consistent. Since 10 per cent of all their cases, having gastric analyses by the fractional method, had an anacidity, there would be quite a high percentage of error if one out of ten with achlorhydria showed an interference with the proper interpretation of the cholecystograms due to this. Lockwood and Skinner (9) believe that neither hyperchlorhydria nor achlorhydria offers any interference to gall-bladder visualization. Out of 1,024 cases studied with cholecystograms and gastric analyses by the Ewald meal, 524 had normal visualization, of which 56 per cent had absence of hydrochloric acid. No roentgenograms were shown for comparison of density of shadows. The capsule method was used, and always in conjunction with bicarbonate of soda. While this is primarily in-

tended to prevent an acid-film envelope of dye from forming about the capsule in the stomach, which would retard absorption of the dye, no doubt much of the visualization of the gall bladder by this method, even though all of the dye is not absorbed, is due largely to the alkali given, with its ultimate effect on the common duct sphincter. While Good and Kirklin (25) state that, with the exception of obstructive lesions of the pyloric outlet, advanced disease of the liver, pernicious vomiting, and protracted diarrhea from any cause, there are no extrabiliary conditions which may influence the cholecystographic response, our investigations have led us to the conclusion that cholecystography in the presence of hyperchlorhydria without the administration of alkali will often result in erroneous interpretation of roentgenograms. A summary of this work

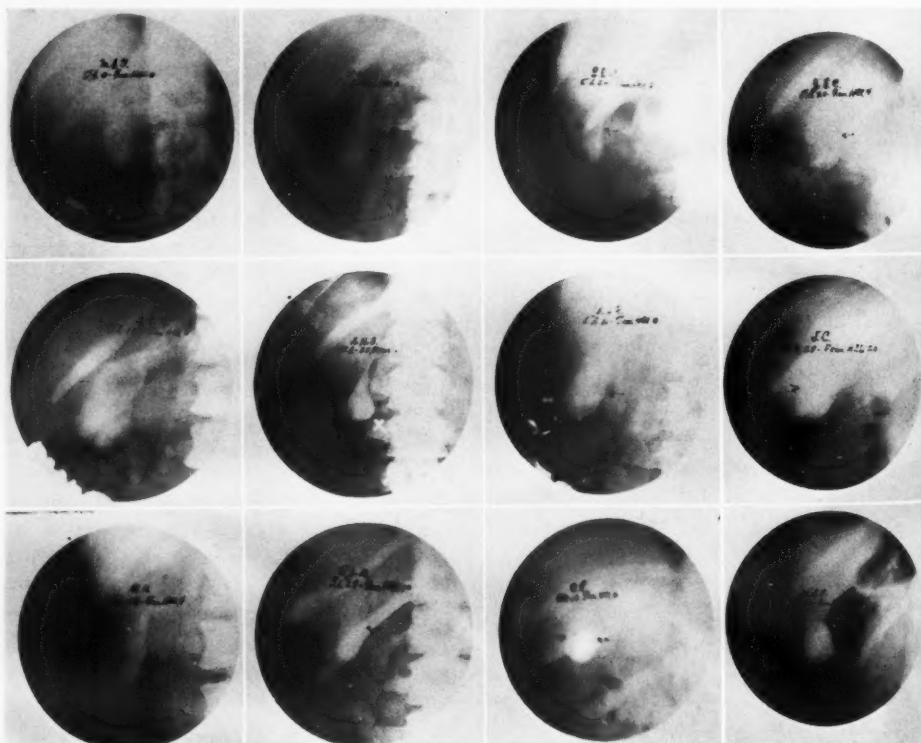


Fig. 2. Representative cholecystograms from a series of 200 cases of gastric sub-acidity not due to cholestatic disease. The old technic was used, the dye being given immediately after fat-free meal, no alkali given. Note the improved concentration of the dye in these gall bladders.

was reported in a paper presented before the Pan-American Medical Congress, in March, 1934. It has been suggested that non-obstructive duodenal ulcer will interfere with visualization of the gall bladder. There is no question but what it will, unless the method of cholecystography employed is based on the recognition of the action of the sphincter of Oddi.

2. Function of Mucosa of the Gall Bladder.—Concentration of the dye-laden bile is promoted by the absorption of its watery content through the lymphatics of the mucosa. Relaxation of the gall-bladder wall is conducive to this process. The experiments of Sosman, Whitaker, and Edson (3) have shown that bicarbonate of soda, by mouth, enforces relaxation of the gall bladder, producing maximum distention of its cavity. No doubt this end-result is consummated by the induced alkaline reaction in the stomach, with its tonic effect on the sphincter of Oddi and the consequent rise in the intra-biliary pressure followed by the secondary relaxation of the gall-bladder wall. Elman and McMaster (4) have demonstrated that this reciprocal action between the common-duct sphincter and the gall bladder exists, and follows the law of contrary innervation. When the gall bladder contracts, the sphincter of Oddi opens, and *vice versa*. With the development of cholecystitis, this reciprocal innervation is disturbed, and most such cases, according to Giordano and Mann (5), show hypertrophy of the sphincter. Cholecystitis has its origin in an interstitial lymphangitis secondary to hepatitis and cholangitis. Rous and McMaster (1) have proven conclusively in their experiments that obliteration of the lymph channels in the mucosa of the gall bladder definitely impairs its power of concentration. The theory that the contrast bile is more readily absorbed through a hyperemic mucosa, which reduces the concentration of the dye in the diseased gall bladder, is supported by the finding of increased bile acids in the blood stream. It is true that the bile acids of the blood are increased in

chronic cholecystitis, but it is questionable whether these enter the blood stream through the walls of the gall bladder rather than through the bile capillaries of the liver.

Kirklin, Caylor, and Bollman (6) have found that the concentration of cholecystographic media by the gall bladder runs parallel with the concentration of bilirubin. Basic morphologic changes affecting the organ as a whole are attended by definite alterations in the bilirubin content of the bile as determined by the quantitative van den Bergh test. Isolated foci of pathologic mucosa do not materially affect the power of concentration, as this is the sum total of the activity of the entire organ. A group of cases with 10 mg. or less of bilirubin per 100 c.c. of bile did not have a gall-bladder shadow. An intermediate group with from 11 to 50 mg. of bilirubin per 100 c.c. of bile, which is the normal variation, showed a response approximating the concentration of the bilirubin. If over 50 mg. of bilirubin per 100 c.c. was found, especially with the higher concentrations, which occurred in cases of chronic cholecystitis with hypertrophic rugæ, papilloma formation, or with small solitary stone, the cholecystographic response to the dye did not occur. The bile was at its maximum concentration when the dye entered the gall bladder, and served only to dilute the latter. This condition is comparable to the dilution of pyelographic media by residual urine in a large hydronephrosis. If the urine is not withdrawn from the renal pelvis before the opaque medium is injected, a poor pyelographic shadow is obtained. Emptying this type of gall bladder of its inspissated bile by use of the fat meal before the dye entered the viscera gave shadows of maximum visualization, although diseased areas of mucosa were definitely present. This finding was of the utmost importance, as it revealed the fact that the dye must be given after the gall bladder has expelled its current bile, if maximum visualization is to be secured in all types of cases.

3. *Function of Contractility of the Gall Bladder.*—According to Levene (16), the time for complete emptying of the gall bladder in response to a fat meal is from three to six hours. Experiments by Ivy (12) prove that this emptying of the organ is actually due to contraction of the intrinsic musculature, though this be poorly developed. This contraction is excited by an absorbed hormone stimulant, so-called "cholecystokinin," which, though it is derived from the duodenal secretions, is not identical with "secretin." It is not only soluble in digested fats, but also in dilute hydrochloric acid. Therefore, sustained alkalinization of the stomach and duodenum during the starvation period retards any contraction of the organ which may occur due to this acid-soluble hormone stimulant, and which would impair visualization of the gall bladder,

particularly in cases of hyperchlorhydria from any cause. Sussman (26) has observed that there is a relationship between hyperchlorhydria and rapid emptying of the gall bladder in the absence of a fat meal, and has remarked that this may be significant in poor visualization of the gall bladder in cases of duodenal ulcer.

Any disease of the muscular coats, or of the serosa, interferes with the normal contraction of the gall bladder after the fat meal. This may occur in an organ which shows a normally functioning mucosa, as exemplified by normal concentration of the dye. The old axiom that a gall bladder capable of filling is able to expel its contents, is quite fallacious. Often it is only during the period of contraction that pathologic changes are noted in the gall bladder. Among the many significant events which may occur during this period,

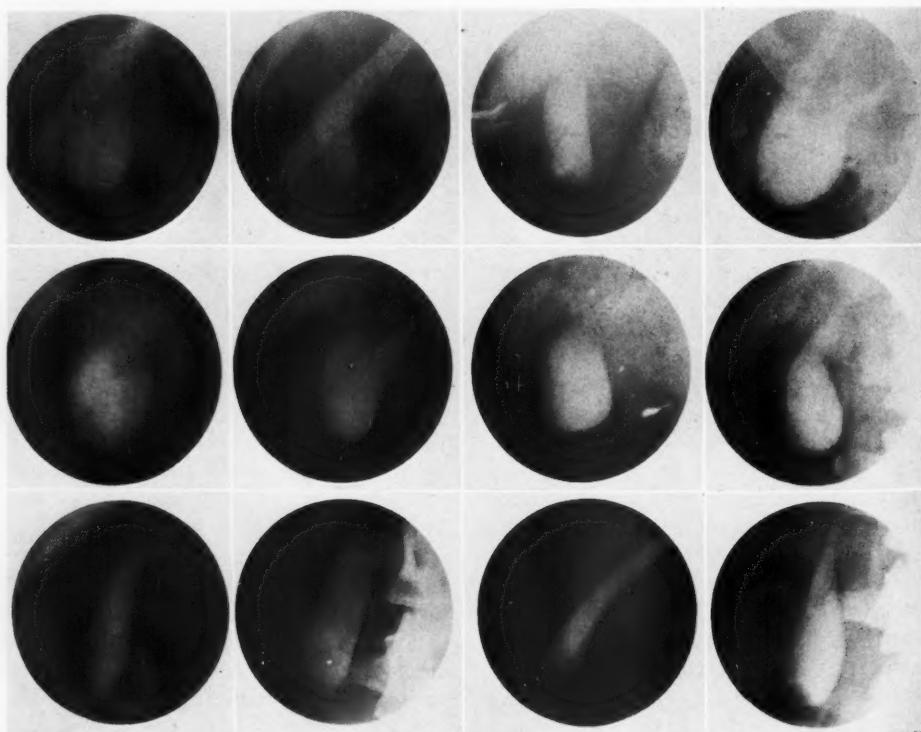


Fig. 3. Representative cholecystograms from a series of 500 cases of normally functioning gall bladders. The new method described was used in its entirety. The dye was given three hours after a fat meal, and alkali was given during the starvation period.

should be mentioned the so-called "fade-away" emptying, or contraction without actual reduction in size, described by Stewart and Illick (18), which characterizes sub-acute or acute inflammation of the gall bladder, as well as pericholecystitis with multiple adhesions. Moreover, Kirklin (14) calls attention to the fact that often it is only at this time that the negative shadows of polypoid tumors of the gall bladder are visualized. Also, small solitary stones, which have been overshadowed by the density of the contrast bile, appear at this time. A retarded contraction of the gall bladder, or so-called persistent shadow, may be recorded, which would signify the presence of a small non-opaque stone in the cystic duct with a ball valve action, or a chronic inflammatory process in the muscular coats of the organ.

TECHNIC OF CHOLECYSTOGRAPHY

Preliminary roentgenograms of the gall-bladder area prior to cholecystography are important, and should always be made a part of the examination in order that a lesion, which may be overshadowed by the opaque bile, may be visualized, and that the desired voltage for the proper taking of the cholecystograms may be established. Small calcium bilirubinate stones, especially if they be single or few in number, may readily be obscured by the dye-laden bile. The finding of characteristic biliary stones would terminate the gall-bladder investigation at this point without cholecystography, but, as Case (8) has shown, pseudovesicular shadows in the upper right quadrant should be interpreted with caution, and should always be studied only after the dye has been given.

Following the preliminary examination, the patient is given four grams of the fresh sodium salt of tetraiodophenolphthalein from a hermetically sealed, amber-colored bottle, four ounces of a fruit juice, and one dram of bicarbonate of soda, or its hydroxyl ion equivalent, along with printed specific instructions as to their use. The patient takes a light evening meal

consisting of two soft boiled eggs, toast well buttered, and a glass of whole milk or a cup of cocoa, the fat content of which will empty the gall bladder of its current bile, and make it receptive to the dye-laden contrast bile. Three hours later, when the gastric acidity is at a minimum, and the effect of the fat meal on gall-bladder contraction has subsided, the dye is first dissolved in one ounce of water placed in a large glass. Then, the fruit acid, usually in the form of iced grape-juice, is added, stirred thoroughly, and the whole dose taken at once. The experiments of Levyn and Aaron (7) have demonstrated that the organic tartaric acid of the grape-juice is sufficient to precipitate the dye in an active, finely divided, acid form, which quickly leaves the stomach along the Waldeyer canal. Thirty minutes prior to the administration of the dye, the patient is given one dram of paregoric, which tends to annul nausea, and, according to Golden (27), counteracts the irritating effect of the dye on the intestine, reduces motility, and thereby enhances its absorption. The ingestion of the dye is followed in one hour by the bicarbonate of soda taken in a small quantity of water. The soda may be made more palatable by combining it with some aromatic carminative, or substituting for it an equivalent dose of one of the alkaline aromaticized antacid powders such as Bisodol or Calbisma. The introduction of this alkali into the stomach, even though it be small in quantity, reflexly increases the tone of the sphincter of Oddi, and thereby relaxes the wall of the gall bladder, both of which are essential to maximum visualization of the gall bladder. Catharsis of any kind is interdicted for the 24-hour period preceding the administration of the dye, as any upset in the normal motility of the small bowel may interfere with the proper absorption of the drug. Water is allowed *ad libitum*, as this tends to increase absorption. During sleep the right lateral decubitus seems to assist in the filling of the gall bladder with the dye-impregnated bile. Vomiting sometimes

occurs, which is objectionable, but the dye is seldom lost in any appreciable quantity, even though this should ensue

shorter intervals. Beginning one hour after the administration of the dye, it is given every two hours, with an average of

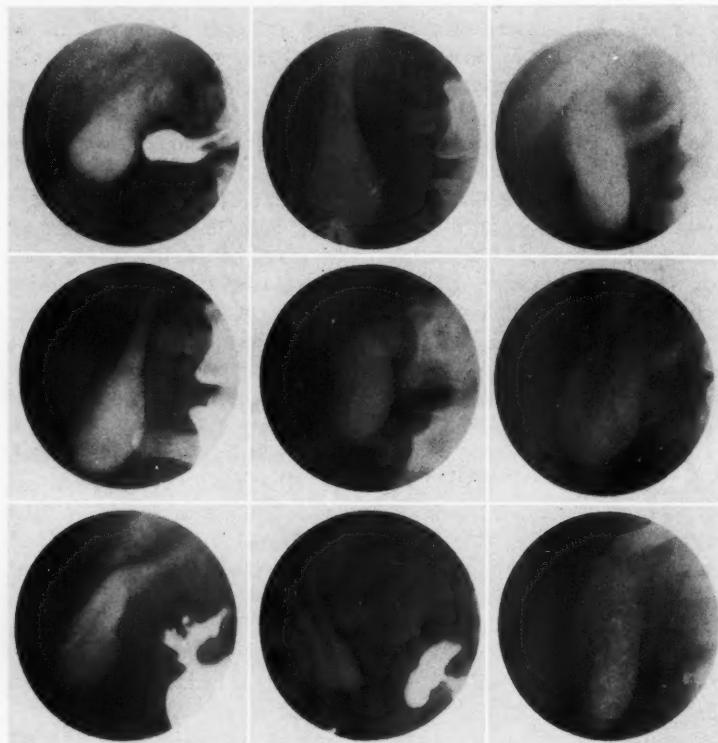


Fig. 4. Cholecystograms made by the new method in cases of post-pyloric ulcer, non-obstructive. Note that there is no interference with concentration of the dye in the presence of hyperacidity.

within 30 minutes after its ingestion. Such a reaction may develop in spite of all precautions. In our experience, it is usually dependent on the condition of the patient at the time of the examination, as often it is noted that it is not repeated at subsequent examinations. Cold applications to the throat is the treatment indicated. The starvation period begins with the administration of the dye, and must be continued until the fat meal is given in order to test contractility of the gall bladder. The average case receives four drams of soda during this period. However, in cases of hyperchlorhydria from any cause the alkali should be given at

eight doses in fifteen hours, which dosage is sufficient to maintain closure of the sphincter of Oddi.

Twelve hours after the dye is taken, the patient reports for the first series of roentgenograms, at which time the gall bladder is at its maximum distention. Four hours later (16 hours after administration of the dye), another series of films are made, which, in a normal gall bladder, should show maximum concentration of the dye with reduction in the size of the viscus. Impairment of concentration in both the 12- and 16-hour roentgenograms, or constant deformity of shadow which persists with change of position of the patient, is

diagnostic of cholecytic disease, and precludes further cholecystographic study. Yet, an organ showing perfect concentra-

examination. The final series of cholecystograms are then taken at two 15-minute intervals, and at the end of one



Fig. 5. Cholecystograms demonstrating the contractile response of a normally functioning gall bladder to an adequate fat meal. The first roentgenogram to the left was taken 16 hours after administration of the dye, and the two roentgenograms to the right were taken 15 and 30 minutes after the fat meal. Note the visualization of the cystic and common ducts, which confirms a normal gall-bladder function and an intact sphincter of Oddi.

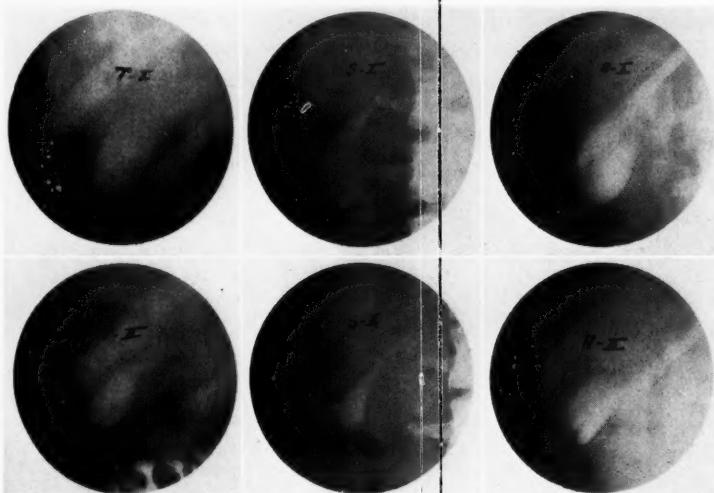


Fig. 6. Cholecystograms of different types of normal gall bladders, demonstrating the contractile response one hour after the fat meal. The top row shows gall bladders 16 hours after administration of the dye, and the lower row demonstrates their respective contractility. Note the smooth contour of the gall bladders during the contraction period, often with increase in concentration of the dye.

tion of the dye and symmetry of contour, with a position corresponding to the habitus of the patient, may manifest every evidence of disease during its contraction. Since active contraction is a fundamental element of gall-bladder function, it is essential in this type of case that a fat meal be given after the 16-hour

hour. Under normal conditions after an adequate fat meal, the last roentgenogram will show uniform reduction of the shadow to one-half or one-third of its original size, often with change in its position, but the continuity of outline remains smooth. Since the investigations of Ivy (22) and his co-workers have shown that emptying

of the gall bladder is accomplished by a protracted contraction of its musculature, and is preceded by increased resistance of the sphincter of Oddi, due to the primary stimulating action of cholecystokinin on its fibers, the 15- and 30-minute films will often demonstrate the cystic and common ducts. We agree with Sussman (26) that the visualization of these provides valuable confirmation of a normal function of the gall bladder and of the sphincter of Oddi. Unquestionably, films taken at three properly spaced intervals, recording the normal cycle of the gall bladder, that of filling, concentration with reduction in size, and emptying, are just as important in cholecystography as the initial study, and the 6- and 24-hour examinations in a gastro-intestinal series.

In order that the negative error in cholecystography, due to faulty interpretation of shadows, (especially those of superconcentration found in chronic chole-

cystitis with hypertrophic mucosal folds in association with small solitary stones or polypoid tumors), may be reduced to a minimum, in order that the time of investigation may be materially shortened without sacrificing thoroughness, and in order that the faint shadow or absence of gall-bladder shadow may have its proper significance, it has been our custom for several years to combine cholecystography with the barium study of the gastro-intestinal tract. The indirect gastric signs of cholecytic disease are recognized as well as those changes in the morphology of the stomach and cap which may be responsible for poor absorption of the dye, such as stenosing pyloric and bulbar ulcers, and cancer of the pyloric canal. It should be emphasized here that obstruction of the pyloric outlet of the stomach and persistent vomiting, from any cause, are the only positive indications in which the intravenous administration of the dye

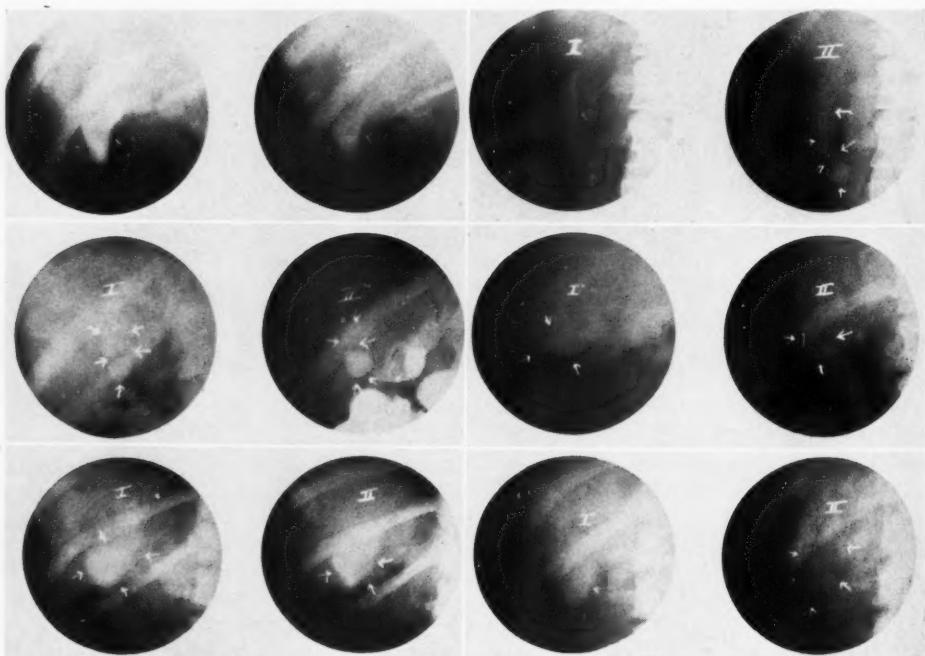


Fig. 7. Representative cholecystograms from a series of cases of pericholecytic disease. These are arranged in pairs, No. I indicating the 16-hour roentgenogram and No. II the roentgenogram taken one hour after the fat meal. Note the fade-away emptying, the marked deformity, or the absence of contraction during the contractile phase of the gall bladders.

should be given preference over the oral method.

Roentgenograms of the stomach and duodenum are made immediately following the 12-hour cholecystograms. The barium meal used is one of seven-ounce volume containing colloidal aluminum hydroxide. Under normal conditions it should be completely evacuated by the stomach within four hours. A dram of bicarbonate of soda is always added to this meal to maintain the effect of gastric alkalinization on Oddi's sphincter, and to relax the duodenal bulb for intelligent study, as recommended by Orndoff. The Lysholm grid is used to distinct advantage in this examination, as diagnostic roentgenograms may be made with it to show the relationship of the gall bladder to the cap and pyloric antrum in the erect and prone postures, as well as to demonstrate the presence of small stones in the fundus of the gall bladder in the erect position which are obscured by the density of the contrast bile in the prone. At the end of the 16-hour period, at which time the second series of cholecystograms are taken, the stomach is normally empty, but any gastric or duodenal residue is recorded on the films and its relation to the gall-bladder shadow is noted. An adequate fat meal is then given. To overcome the aversion for the Boyden fat meal which many patients have, and yet use an effective gall-bladder stimulant which does not interfere with gastric motility, it has been our routine procedure to employ glyconin fortified with lecithin, as suggested by Levyn (19). This is administered in the small amount of from one-half to one ounce in a palatable fruit juice, and is practically tasteless. Oleic acid in one-dram doses will produce excellent gall-bladder contraction, but it is difficult to conceal its disagreeable taste with any kind of vehicle. If pericholecystic adhesions are present, with a barium residue in the cap and pyloric antrum, the latter may be displaced to the right by the gall-bladder contraction one hour after the fat meal. This finding may be the only evi-

dence of disease, as the contour of the cholecystographic shadow may be perfectly smooth. Under normal conditions the gall-bladder examination is concluded before the barium column has reached the hepatic flexure of the colon. It is seldom that the barium-filled or gas-distended colon overshadows the dye-filled gall bladder and interferes with the proper interpretation of films. If such difficulty should arise, it is usually manifested in the 16-hour cholecystograms. If the gall-bladder shadow is only partially obscured, roentgenograms in both the prone and erect positions are made to ascertain if a fixed relation exists between the gall bladder and the colonic shadows, as this finding may signify the presence of adhesions between the gall bladder and the hepatic flexure of the colon. Following this procedure, it is our routine to complete the four-hour examination of the gastro-intestinal tract at this time, and, in the absence of hypertension or hypotension, resort to the use of pitressin in doses of 1 c.c. given intramuscularly in the deltoid. The 20-pressor units of posterior pituitary extract are usually highly effective in eliminating all confusing shadows in the intestinal tract, including both barium and gas shadows, without affecting the status of the gall-bladder function. After one hour, during which time one or more stools occur, another set of cholecystograms are made, followed by the fat meal. After the series of films recording the contractile response of the gall bladder are made, the patient may be given one ounce of castor oil preparatory to a barium-enema examination of the colon on the following morning. However, if the cholecystograms show a questionable faint shadow or absence of gall-bladder shadow, catharsis is omitted, barium-enema examination deferred, and a second dose of the dye is given the second night and the cholecystograms repeated the following day. Often, enough of the barium remains in the colon to permit a study of this the following morning, and, because of this, it may be necessary to repeat the dose of pitressin

to obtain satisfactory films of the gall bladder. Collins and Root (24) employ the combined method of cholecystography

While the preparation of the patient for cholecystography and the routine management of the procedure must be

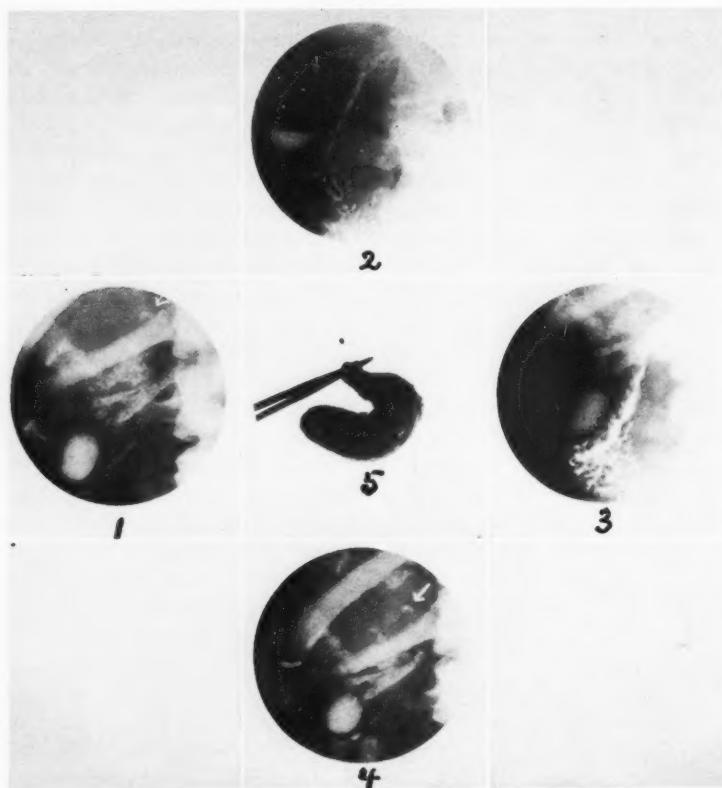


Fig. 8. A case of Charcot's intermittent hepatic fever. No. 1 shows a 12-hour roentgenogram of a gall bladder with arrow indicating a ball-valve stone in the common duct. No. 2 shows the gall bladder in the erect position in its relation to the duodenum—note fluid level in gall bladder. No. 3 shows the gall bladder in the prone position in its relation to the duodenum. No. 4 shows a roentgenogram of the gall bladder one hour after the fat meal. Note the contraction of the gall bladder and the presence of the stone in the common duct (see arrow). No. 5 shows the gall bladder and stone removed at operation. The gall bladder was biloculated, and only the normally functioning proximal loculus was visualized in the cholecystograms.

in a similar manner and have reported a high degree of accuracy in the results obtained. We concur with them in their conclusions that the combined method is to be preferred to the intensive multi-dose method of study as a routine measure, as the latter may even increase rather than reduce the negative error in cholecystography due to faulty interpretation of the super-density of the shadows produced.

most exacting, we agree with Kirklin (15) that the actual technic of making the cholecystograms from a roentgenographic viewpoint should also be precise in every detail. The patient should be draped in a one-piece garment and made absolutely comfortable on the Bucky table, that thorough relaxation of all muscular structures may be secured. Immobilization of the parts with rubber air-filled bladder and

compression band is carried out. The oblique positions are best suited to bring the gall-bladder shadow into clear relief. The correct centering of the roentgenographic field for the asthenic type of patient is the left anterior oblique projection which casts the gall-bladder shadow away from the spine, whereas in the hypersthenic type, the right anterior oblique displaces the organ toward the spine and from underneath the liver shadow. Exposures are made at the end of exhalation, and the shortest exposure compatible with good Bucky technic should be used, together with a cone and super-speed thick and thin screens. The kilovolts peak should be minimal for the penetration of the part under examination. A line focus tube will give greater definition at the higher milliamperages. We employ a line focus tube with fine focal spot in conjunction with a high speed flat top Bucky diaphragm, and make ultra-fast exposures of from 1/10 to 1/5 of a second with a condenser machine. The contact switch of the Bucky is connected to the discharge switch of the condenser. Closure of the magnetic release switch of the Bucky sets the grid in motion and closure of the contact switch makes the exposure, the time of which is governed by the filament current in the Coolidge circuit. Diagnostic roentgenograms should show the right costal margin, crest of the ilium, and lumbar spine, with fair bone detail in each, as well as the shadow of the liver margin and an outline of the right kidney.

SUMMARY AND CONCLUSIONS

1. A plea has been made for the standardization of the technic of oral cholecystography.

2. Since cholecystography is primarily an index of the functional activity of the gall bladder, if the maximum in pathology is to be found in all types of cases, any reliable method used to visualize the organ, whether by oral or intravenous administration of the dye, must be based on the recognition of the underlying physiologic principles.

3. The whole of the gall-bladder cycle, that of filling, concentration with reduction in size, and emptying, must be observed.

4. It is imperative that the sphincter of Oddi remain contracted during the starvation period in order that a maximum volume of the contrast bile enter the gall bladder. Maintenance of alkalinization of the stomach and duodenum sustains, on the one hand, tonic contraction of the common duct sphincter, and, on the other, prevents contraction of the gall bladder, indirectly inducing its relaxation.

5. An empty, relaxed gall bladder permits maximum concentration of the dye-laden bile. It is, therefore, important that a fat meal be given three hours preceding administration of the dye.

6. No cholecystographic examination in cases of gall bladders of normal or super-normal concentration is complete without testing the contractility of the viscus. Often, it is only during the period of contraction that evidence of disease presents itself.

7. Correlation of cholecystographic study with the gastro-intestinal series is of distinct value in reducing the negative error of interpretation to a minimum.

8. Except in cases of persistent or pernicious vomiting, from any cause, and in obstructive lesions of the pyloric outlet of the stomach, intravenous cholecystography is seldom indicated.

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DISCUSSION

WALTER W. ROBINSON, M.D.: The question was asked if the gall bladder ever refills after a fat meal has been given to test its contractility. Often it does refill, as shadows of good density are noted in the roentgenograms made during the 24-hour gastro-intestinal examination. The dye is reabsorbed from the gastro-intestinal tract, and the concentration in the gall bladder at 24 hours is dependent in the inverse ratio on the amount of fat ingested with the meals during the interval between examinations.

PRACTICAL RESULTS OF RESEARCHES ON IRRADIATION EFFECT ON GENES AS APPLIED TO ROENTGEN THERAPY AND ROENTGEN DIAGNOSIS¹

By A. PICKHAN, Berlin

SINCE the fundamental work in radio-genetics by H. J. Muller² it has been shown consistently by all experimenters that short wave radiation possesses a mutation-producing effect. This was demonstrated in the case of ultra-violet light by Altenburg (1934); for Grenz rays by Timofeef-Ressowsky and Zimmer (1935), Wilhelmi, and Timofeef-Ressowsky (1931); for x-rays of different degrees of hardness by Muller (1928, 1930, and 1934), Oliver (1932 and 1934), and Timofeef-Ressowsky (1931, 1934, and 1937); for radium rays and alpha rays by Zimmer and Timofeef-Ressowsky (1936); for beta and cathode rays by Hanson and Heys (1929) and Timofeef (1931 and 1934), and for gamma rays by Hanson and Heys (1929), Pickhan (1935), and Timofeef-Ressowsky (1937). Extensive research with beta rays was carried out by Zimmer, Griffith, and Timofeef-Ressowsky, in 1937.

All these authors came to the conclusion

¹ Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13-17, 1937.

² Editor's Note: Lethal mutations provide the most feasible approach to this study. The usual method of locating a lethal appears as follows: A character linked to a lethal appears in numbers proportional to the crossing over between the two genes. If, then, it is desired to test a group of chromosomes for lethals, crosses to a stock with convenient marking genes afford the method. By proper further crosses, it is then possible to ascertain the presence and locus of the lethal.

Refinements to this method are usually utilized. In *Drosophila* and in cases in which the male is the heterozygous sex, a new sex-linked lethal reveals its presence by a ratio of two females to one male. The use of sex-linked marking genes provides a further check; the surviving males must bear a special relation to the marking genes, depending on the locus of the lethal. If by some means, crossing over is suppressed between the chromosomes in question, only one type of male should appear. There are in *Drosophila* at present a number of stocks which make such tests possible. The first and most widely used is Muller's C1B stock, described in his 1928 paper (Genetics, 13, 279-357, 1928). In this method the presence of a new lethal is detected by a progeny consisting entirely of females.

that all types of radiations which they used produced mutations, and that the rate of mutation thereby produced is in direct and linear proportion to the height of the dose used and was independent of the wave length.

Almost all the researches mentioned here were carried out by means of the C1B method on *Drosophila melanogaster*, which seems to be the most thoroughly investigated and tested object for researches on mutations. This C1B grouping method permits determination of all lethal mutations and particularly those which are tied up with sex.

Three to six days after emergence from the chrysalis, P-males³ are irradiated in a suitable manner and paired with unfertilized C1B females three to six days old. The F₁-C1B females, which, in addition to the C1B-X-chromosome from the mother, receive also the irradiated X-chromosome of the father, are crossed with their brothers. In the F₂ males all the mutations produced by irradiation of the X-chromosome in the P-males are demonstrable.

All investigations of recent times on the biologic effect of radiations of different quality are based on the most exact physical measurements and usually on ionometric ones.

R. Fricke and O. Glasser, as well as Friedrich and Zimmer, have shown that use of the air wall small chamber gives an exact determination of *r*, and for that reason a comparison of the magnitude of the dose of all kinds of radiation is possible.

We can cite as demonstrated facts:

1. The height of the rate of mutation so produced is in direct and linear proportion to the height of the dosage of radiation used.

³ P, means parents; F₁, means first generation; F₂, means second generation; I.t = K, means intensity time equals a constant.

2. The time factor is without effect on the rate of mutation: the smaller radiation doses and the weakest intensity by repetition produce cumulation.

3. The process of mutation in contrast to physical reactions is not reversible, as a mutation is the transition of an exceedingly stable gene into another condition which is just as stable (type of the monomolecular reaction).

In the living world we know there is a minimal mutation rate (spontaneous mutation). This varies in the case of *Drosophila melanogaster* between 0.3 and 0.6 per cent. The rate of mutation in *Drosophila melanogaster* as determined from the average of all researches is 42.47 per cent with 1,000 r. The gene-containing portion of the X-chromosome is 1/6 to 1/7 of the total complex. The mutability of the various fractions of the complex, therefore, is about constant on the average. The total mutation rate in *Drosophila melanogaster* after irradiation with 1,000 r is about 42 per cent. One r, therefore, produces 0.04

per cent of the total mutation. To produce the average mutation rate (0.4 per cent) we need a radiation quantity of about 10 r. From this we can conclude that:

1. In therapy the use of higher doses than those determined here is permissible only in cases in which the possibility of later pregnancy is not to be considered; that is to say, if the patients have passed the menopause or in case of some disease in the treatment of which a sterilization as an end-result is of little consequence.

2. In x-ray examination of the region of the sex organs—for example, in fluoroscopy and in roentgenography of the female pelvic organs (in pregnancy and in salpingography)—great attention should be paid to the number of r delivered by these procedures. Attention should be further paid to the fact that in radiogenetics the $I \cdot t = K$ law is valid; also in contrast to physiologic reaction the time factor is without effect, so that repeated small doses, independent of the time in which they are given, lead to cumulation.

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CRANIOLACUNIA (LÜCKENSCHÄDEL)¹

A REPORT OF 54 CASES

By EDWARD C. VOGT, M.D., and GEORGE M. WYATT, M.D., *Boston*

From the Department of Roentgenology of the Infants' and the Children's Hospitals

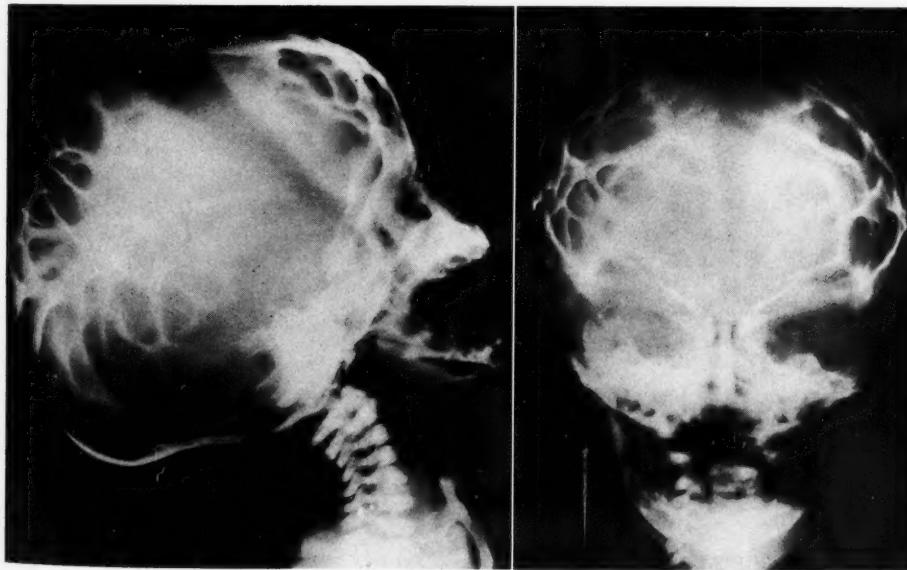
CRANIOLACUNIA, a condition known in the literature as "lacunar skull" and "Lückenschädel," has attracted the interest of several European authors. In the American literature, attention was called to this condition by Kerr (2) and by Doub and Danzer (1), who summarized and discussed the previous literature in addition to reporting their own observations. Except for these papers, only occasional mention has been made of this finding.

The roentgenologic appearance in a typical case of craniolacunia is that of an

arborizing pattern of bony ridges which sharply delineate and separate rounded defects one from another (Figs. 1-A and 1-B). In the pathologic specimen, these defects may be completely devoid of bony structure, in which case they are bridged by membranous diaphragms of periosteum and dura. Some of the defects may have an additional covering of bone which corresponds to the outer table of the skull, the inner table being incomplete (Fig. 2). There is considerable variation in the degree of involvement, even among lesions in the same skull.

These perforations and depressions are well described by the word "lacunæ." The term "craniolacunia" is suggested for this condition in preference to the previ-

¹ Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11-15, 1939.



Figs. 1-A and 1-B. A typical example of marked craniolacunia. (Age, 18 days.) Note the arborizing patterns of bony ridges which sharply delineate and separate rounded defects one from another. This patient had a large lumbosacral meningocele.

ously used terms "Lückenschädel" and "lacunar skull," because it represents a form of nomenclature which is not limited to a single modern language.²

Several theories have been advanced regarding the etiology of craniolacunia, including an explanation on the basis of increased intracranial pressure during fetal life. To our knowledge, none of the theories has been proved. This condition apparently falls in the same unsatisfactory category as the majority of congenital anomalies, the causes of which are still obscure.

The clinical significance of craniolacunia is of interest, and is almost invariably a subject for discussion whenever an example is encountered. Its close association with meningocele has aroused considerable speculation. This study was

undertaken in an effort to determine the relation of craniolacunia to meningocele and to evaluate its clinical significance.

RELATION OF CRANIOLACUNIA TO MENINGOCELE

During a six-year period, from 1932 to 1938, approximately 6,000 skull examinations were made in the Department of Roentgenology of the Infants' and the Children's Hospitals. One hundred and twenty of these examinations were carried out on patients with meningoceles. Skull films were omitted in only one case of meningocele referred to the Department of Roentgenology during this period.

Many of these examinations revealed depressions in the inner table of the skull. These were particularly deep in cases of oxycephaly, scaphocephaly, and brain tumor. In a few skulls, such depressions were pronounced in the absence of any neurologic abnormalities or significant history. Depressions of a different type,

² We are grateful to William F. Wyatt, Professor of Greek, Tufts College, for his assistance in the choice of this term.



Fig. 2.

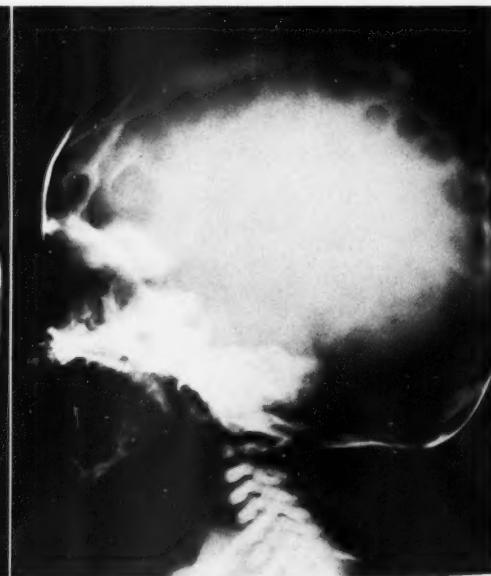


Fig. 3.

Fig. 2. Specimen film of the calvarium of the skull shown in Figure 1. The complete defects are bridged by periosteum and dura. The incomplete defects have an additional covering of bone corresponding to the outer table of the skull.

Fig. 3. An example of craniolacunia in which the involvement is most marked in the frontal bone. (Age, six days.) Lumbar myelomeningocele.

however, were found in the group of patients with meningocele.

There was no difficulty in differentiating craniolacunia, characterized by absence of bone in the depressions, from skulls altered by brain tumor, scaphocephaly, and oxycephaly. Actual perforation never resulted from increased intracranial pressure alone. Those skulls with only partial thinning of the inner table presented more of a diagnostic problem. Several points of differentiation were noted, however, the most significant of which were as follows:

1. *Contour.*—The lacunæ were clearly demarcated by bony ridges, with a resulting delineation which was sharper and more abrupt than that of the convolutional markings associated with other conditions.

2. *Distribution.*—The lacunæ usually were more closely spaced than cerebral gyri, and formed a coarsely reticular, arborizing pattern as contrasted with the more linear and parallel pattern of convolutional impressions. All of the bones of the vault were involved in most cases, although the involvement often was most marked in the frontal or parietal bones (Fig. 3).

3. *Age.*—Craniolacunia usually was

seen in early infancy, at which age the developing brain is gelatinous in consistency. It is difficult to conceive of such a brain forming convolutional impressions in the skull. Convolutional markings seldom were evident under the age of one year, whereas the lacunæ associated with meningocele were most marked immediately after birth and were often obliterated after one year. This latter was particularly true in patients with craniolacunia who developed hydrocephalus (Figs. 7-A and 7-B).

In this study, cases which met the above criteria were regarded as true examples of craniolacunia. These were divided into two groups: complete and incomplete defects (Figs. 4 and 5).

Only two cases of true craniolacunia were seen in the group of over 5,000 patients without meningocele (Fig. 6). Both of these patients were mentally defective and one of them showed hydrocephalus by encephalography. No adequate explanation for the mental deficiency or hydrocephalus was discovered in either of these patients. The finding of only two examples of craniolacunia in a group of over 5,000 patients without meningocele indi-



Fig. 4.

Fig. 4. Craniolacunia with minimal involvement. (Age, five weeks.) Thoracic myelomeningocele. The lacunæ in this case apparently are limited to the inner table of the skull.

Fig. 5. Craniolacunia of marked degree with defects which involve the entire thickness of the skull. (Age, two days.) Encephalomeningocele.



Fig. 5.

cates extreme rarity of this condition in the absence of meningocele.

The incidence was quite different in the group of 120 patients with meningocele. Fifty-two (43 per cent) of these showed varying degrees of craniolacunia. An analysis of its incidence in respect to the size and location of the meningocele seemed indicated. To this end, the patients with meningoceles were divided roughly into three classes, according to the size of the meningocele: small, medium, and large, and into four classes, according to the location of the meningocele: head, cervical spine, thoracic spine, and lumbosacral spine. This classification necessarily was crude because some of the meningoceles had ruptured before examination, the spinal defects had to be taken into consideration, and the larger meningoceles sometimes involved more than one segment of the arbitrary division used. A working basis for general comparison, nevertheless, was afforded by this classification (Table I).

Craniolacunia was less frequent in association with the smaller meningoceles. The size of the meningocele otherwise had no significant relation to the presence or degree of lacunar change in the skull. The location of the meningocele seemed of

significance only in the group of thoracic meningoceles, 91 per cent of which were associated with craniolacunia. The remainder of the examples of craniolacunia occurred with about the same frequency in the presence of cephalic, cervical, and lumbosacral meningoceles.

Sixty of the patients with meningocele underwent operation, and in these patients it was possible to determine whether the meningoceles were of simple character or true myelomeningoceles, containing nerve tissue. Craniolacunia was associated with 12 per cent of the simple meningoceles, and with 53 per cent of the myelomeningoceles (Table II).

Separated cranial sutures were noted in 23 per cent of the meningoceles without craniolacunia and in 26 per cent of those with this change. This parallel incidence is interesting in relation to the theory of increased intracranial pressure during fetal life as a cause of craniolacunia. If increased intracranial pressure late in fetal life were of importance as a causative factor, the consequences should be apparent in the form of separated sutures shortly



Fig. 6. Film of one of the two cases of craniolacunia encountered in the group of over 5,000 patients without meningocele.

TABLE I

Relation of Craniolacunia to Meningocele

No. Patients with Meningocele	No. Patients with Craniolacunia	No. Patients without Craniolacunia
120	52 (43%)	68 (57%)

Relation of Craniolacunia to Size of Meningocele

Size of Meningocele	No. Patients	With Craniolacunia	Without Craniolacunia
Small (under 3 cm.)	17	4 (23%)	13 (77%)
Medium (3 to 8 cm.)	39	21 (54%)	18 (46%)
Large (over 8 cm.)	64	27 (42%)	37 (58%)

Relation of Craniolacunia to Location of Meningocele

Location of Meningocele	No. Patients	With Craniolacunia	Without Craniolacunia
Head	29	11 (38%)	18 (62%)
Cervical spine	7	3 (43%)	4 (57%)
Dorsal spine	12	11 (91%)	1 (9%)
Lumbosacral spine	72	27 (37%)	45 (63%)

after birth. Our experience lends no support to this theory.

CLINICAL SIGNIFICANCE OF CRANIOLACUNIA

Since all but two of the 54 cases of craniolacunia occurred in association with meningocele, the logical control for this study appeared to be the accompanying group of 68 cases with meningocele but without craniolacunia.

The 120 cases with meningocele were studied from the standpoint of clinical result, and divided into four groups as follows:

1. *Good.* These patients had normal mental development, and no disabling deformities or neurologic lesions.

TABLE II.—RELATION OF CRANIOLACUNIA TO TYPE OF MENINGOCELE

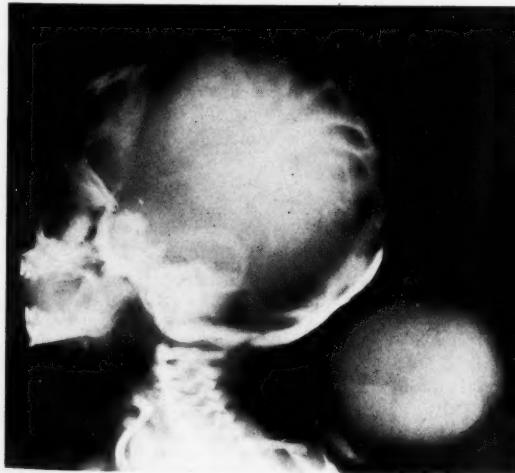
(In 60 Patients Who Underwent Operation)

Type of Meningocele	No. Patients	With Craniolacunia	Without Craniolacunia	Clinical Result	No. Patients	With Craniolacunia	Without Craniolacunia
Simple meningocele	26	3 (12%)	23 (88%)	Fair	16	1 (6%)	15 (94%)
Myelomeningocele	34	18 (53%)	16 (47%)	Poor	22	14 (64%)	8 (36%)

TABLE III.—RELATION OF CRANIOLACUNIA TO CLINICAL RESULT

(In 120 Patients with Meningocele)

Clinical Result	No. Patients	With Craniolacunia	Without Craniolacunia
Good	19	2 (10%)	17 (90%)
Fair	16	1 (6%)	15 (94%)
Poor	22	14 (64%)	8 (36%)
Dead	35	20 (57%)	15 (43%)
No follow-up	28	15 (54%)	13 (46%)



A



B

Figs. 7-A and 7-B. Marked craniolacunia with large occipitocervical myelomeningocele. (Age, two days.) The second film was taken a year and a half later, after hydrocephalus had developed. The lacunar deformity is almost completely obliterated in the second film. (The operative defects followed coagulation of the choroid plexus for hydrocephalus.)

The comparison of the clinical results in cases of meningocele with and without craniolacunia is shown in Table II. It is evident from these figures that the patients with craniolacunia did more poorly than those without this lesion. Good results were obtained in only two patients (4 per cent) of the group with craniolacunia, whereas 17 patients (25 per cent) of the control group with meningocele had good clinical outcomes.

All of the patients in whom good results were obtained had simple meningoceles with the exception of two, neither of whom had craniolacunia.

Progressive hydrocephalus was one of the most serious complications encountered in patients with meningocele; it was present in 48 per cent of the patients with craniolacunia, and in 25 per cent of the patients without this lesion.

DISCUSSION

Craniolacunia occurred in 43 per cent of patients with meningocele. An analysis of its relation to various sizes and locations of meningocele failed to show any constant correlation. It was present least frequently in association with the smaller meningoceles and occurred most frequently in the presence of thoracic meningoceles, but it did occur with the smallest meningoceles and was absent in one of the cases of thoracic meningocele. If it were limited to patients with huge meningoceles or to those with a large amount of nerve tissue in the sac, the fact that the group of patients with craniolacunia did poorly might be attributed solely to the type of meningocele involved. In view of the distribution of craniolacunia throughout the group of meningoceles, however, its presence in these patients is of considerable significance.

The prognosis should always be guarded in patients with meningocele. Many of these patients, however, including two with craniolacunia, have had good clinical outcomes. Our studies indicate that the presence of craniolacunia in a patient with

meningocele must be regarded as an unfavorable prognostic finding.

SUMMARY AND CONCLUSIONS

1. Skull films were taken of 120 patients with meningocele in the course of approximately 6,000 consecutive skull examinations.
2. Craniolacunia was present in 43 per cent of the 120 patients with meningocele.
3. Only two cases of craniolacunia occurred in the remaining group of over 5,000 patients without meningocele.
4. Craniolacunia was least frequent in the presence of the smaller meningoceles, and most frequent in association with the thoracic meningoceles. Its incidence in cases of meningocele was unaffected otherwise by the size or location of the meningoceles.
5. Craniolacunia was found more frequently in association with myelomeningocele than with simple meningocele.
6. The presence of craniolacunia must be regarded as an unfavorable prognostic sign in patients with meningocele.

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DISCUSSION

HOWARD P. DOUB, M.D. (Detroit, Mich.): Dr. Wyatt has again demonstrated to us what can be accomplished by a man who is enthusiastic and interested in a subject which was previously thought to be a rare condition.

By systematic examination of the skull in these cases of meningocele, he has demonstrated that this is not a rare condition but a moderately common one.

It is unfortunate that we do not know the etiology of the condition and that the treatment is rather unsatisfactory.

From the standpoint of the radiologist, it seems to me that we must examine the

skull of every child who is sent to us for examination of a meningocele.

I would like to make the point that, if these cases are to be discovered, it must be done by the radiologist. Very few clinicians recognize the existence of this condition and we must bring it to their attention more clearly so that they also may be on the lookout for it.

I think that Dr. Wyatt has done an excellent job in assembling all the available information and has added to that from his series of cases. He has brought this subject definitely up-to-date before us.

IMPORTANCE OF ACCURATE COLLIMATION OF THE BEAM IN DEEP ROENTGEN THERAPY¹

EFFECT OF THE SIZE OF THE FOCAL AREA AND POSITION OF THE LIMITING DIAPHRAGM, WITH SPECIAL REFERENCE TO SUPERVOLTAGE

By EDWARD SCHONS, M.D., *St. Paul, Minnesota*

RADIATION sickness, one of the oldest bugbears of radiation therapy, is still an every-day reminder that intensive irradiation is detrimental rather than beneficial to an organism. Gross damage to normal tissues also serves not infrequently to remind us that tumors are not the only structures sensitive to irradiation, but that the neighboring normal tissues may often be as sensitive or more so than the tumor itself. Since relatively enormous doses are frequently necessary to destroy or materially retard a tumor, it is evident that largely by refinements in the method of application, designed to spare the normal tissues and the organism as a whole to the utmost possible extent, dare we hope for measurable improvement in the results in many types of malignant disease.

The importance in deep radiation therapy of keeping the irradiated volume as small as possible, consistent with complete irradiation of the disease focus, can, therefore, not be over-emphasized. To this end we must first determine as accurately as possible the location and probable limits of the disease. The size and shape of the beam should then be so chosen for each port of entry that the entire tumor involvement and a safe surrounding zone, but no more, be included, and that especially vulnerable normal parts be excluded insofar as is possible.

While these principles as regards external irradiation of deeply situated tumors have been well known for many years, it is often difficult to apply them adequately in practice. Two factors which may contribute considerably to irradiation of an undue

volume of tissue are the size of the x-ray source and the position of the diaphragm or mouth of the cone limiting the size of the field. The ideal of a point source which would eliminate this problem (Fig. 1) cannot practically be even approximately attained, a ratio of about 1 to 25 of the mean diameter of the focal spot to the target-skin distance being necessary for purposes of heat dissipation. I wish, therefore, to discuss the effect of the size of the focal spot and the position of the limiting diaphragm on the radiation beam and on the volume of tissue which is irradiated, as provided particularly in some types of supervoltage equipment.

Any diaphragmed beam of x-rays coming from an area of finite size rather than from a point source has a penumbra, or fuzzy zone, the relative width of which on a field at a certain distance from the target depends on the size of the focal area and the distance of the diaphragm from the field (Fig. 2). When the diaphragm limiting the size of the field is placed on the skin (and no other diaphragm removed from the skin and small enough to cut off a view of part of the focal area from the peripheral parts of the field is present), there is no penumbra on the skin surface. When, however, the limiting diaphragm is placed some distance from the treatment plane, we have a penumbra zone of gradually lessening intensity on the skin, around the central zone of full intensity. The width of the penumbra zone varies according to the size of the focus and according to the angular or radial direction with reference to its usually oval projected shape, the zone being wider in the direction of the long axis of the focus. As the diaphragm is gradually made larger and placed nearer

¹ Presented at the Third International Cancer Congress, at Atlantic City, N. J., Sept. 11-16th, 1939.

to the skin surface (maintaining the same skin area), the penumbra on the skin becomes proportionately narrower until it completely disappears, when the diaphragm coincides with the plane of the skin. With the diaphragm limiting the size of the field located at the skin surface, a penumbra still appears below the skin and increases in width with the depth below the surface. This penumbra is unavoidable and represents the maximum sharpness of delimitation of the cone of radiation which can be obtained in the body with a focal spot which is not a point. The smaller the focal spot, the narrower this zone and the more sharply defined the useful cone or pyramid of rays. The larger, conversely, the effective size of the focal area, the greater the peripheral zone of decreasing intensity.

It is known that, other things being equal, the beam of supervoltage radiation

is more sharply defined in the tissues than is a 200 kv. beam, due to less scatter in the backward direction. By improper diaphragming, however, this advantage of supervoltage radiation may be easily sacrificed. This paper, therefore, chiefly concerns supervoltage installations, though the same considerations apply when a 200 kv. beam is used without proper final diaphragming at or near the skin surface.

It is quite common practice in the case of 200 kv. radiation to delimit the skin area accurately, either with a sufficient variety of sizes and shapes of radiopaque cones placed close to the skin, or by means of thick lead rubber strips laid on the skin and cones adequate to cover the area. In the case of supervoltage, however, it has not yet become routine practice to supply a sufficient number of cones of different sizes and shapes and the field cannot well be outlined by lead or lead rubber laid

ILLUSTRATION OF PRINCIPLE

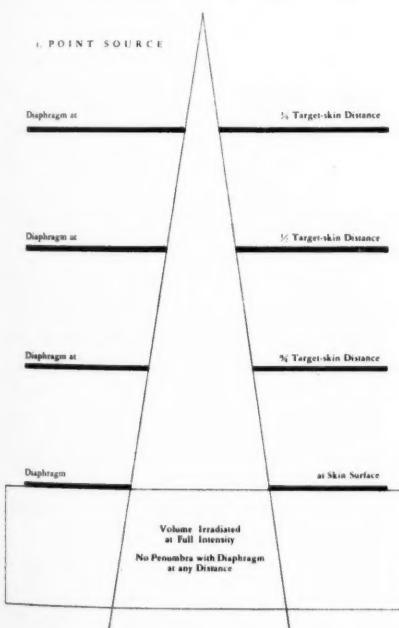


Fig. 1.

ILLUSTRATION OF PRINCIPLE

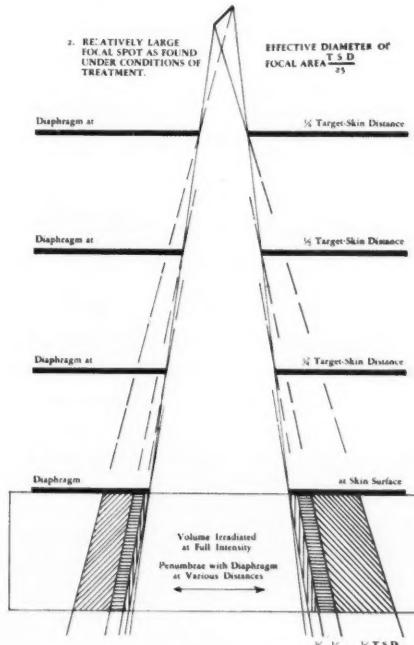


Fig. 2.

Fig. 1. Point source (ideal, theoretical).
 Fig. 2. Relative size of focal area under actual conditions, showing penumbra with diaphragm at various distances.

upon the skin, because of the necessary weight and, in the case of horizontal beam installations, by the impracticability of placing and retaining this in position.

It is, therefore, apparent that if the focal spot is relatively large and the final diaphragm a relatively great distance from the skin, the resulting zone of partial intensity at the periphery may mean either relatively inadequate radiation of the peripheral portions of the volume which one intends to irradiate or a considerable amount of unnecessary body irradiation. This is important whether the area of involvement can be accurately determined or not, as the beam which one decides to use in a given case should be of full intensity throughout, and there should be no additional considerable volume of partial intensity. It is of especially great importance in instances in which it is desired to apply highly intensive radiation to a relatively small and well defined, but deeply situated, tumor mass, which may or may not be very radiosensitive, by cross-firing with many small beams. In such a case the possible considerable percentage of additional, unnecessary, and undesirable radiation at the periphery of the beam due, with a relatively large focal area, to lack of proper diaphragming as near the skin as possible, may be quite large and may cause an unnecessary amount of damage to the normal tissues. Or it will reduce the amount of radiation which could otherwise be safely concentrated on the tumor. In cases in which large fields must be irradiated, the treated volume is already large and the radiation effect taxing to the patient, so that even

moderate increase beyond that actually necessary should be avoided.

Our supervoltage equipment consists of a vertical mid-ground tube of the Lauritsen type, which we are operating at one million volts, constant potential. This voltage is produced by a generator utilizing the Cockcroft-Walton Circuit. The useful beam is taken off horizontally, at 90° to the electron stream. Four portals separated 90° are provided. The target, a thin lead coating deposited on a sheet of copper 2 mm. thick, is set at an angle of 45° to the horizontal and quartering to each portal. Radiation is taken from the face of the target at two ports and through the target at the other two ports. The output is 20 r per min., in air, at 100 cm. at all ports, those from the face of the target requiring one and one-half mm. more lead filtration than those taking the radiation through the target. The effective focal spot at each port is an inclined oval area, measuring 2.9×5.7 cm. as shown by pinhole radiographs (Fig. 3-A). Most of the radiation comes from a zone at the periphery of the focal spot. Comparatively little radiation comes from parts of the target other than the focal spot. At 100 cm., our target-skin distance, the effective focal area compares not unfavorably with 200 kv. tubes at 50 cm. focal-skin distance, the one in use on our 200 kv. machine at present measuring 2.7 cm. in its longest diameter.

For illustration we shall assume the simple geometric cases of a phantom 15 cm. thick, irradiated with 1,000 kv. rays at 100 cm. distance. We shall irradiate round fields, respectively, 15 cm. and 5 cm. in diameter, each with the limiting diaphragm directly on the skin and, again, at a distance of 22 cm. from the skin, which happens to be the position of our variable diaphragm (Fig. 4).

Although the projected shape of the focal area of the target is actually an oval, we shall assume, for convenience in calculating, as sufficiently accurate for our purpose, an effective round focal area. In order to avoid the toe and heel effect of an oblique target surface, we have assumed

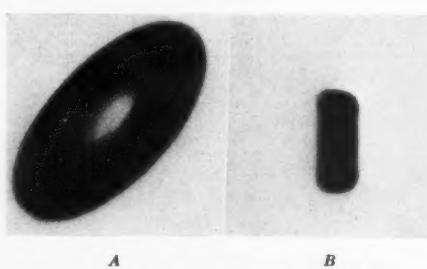


Fig. 3. Supervoltage and 200 kv. focal areas to same scale.

this to be perpendicular to the central ray. We shall assume the diameter of the focal area to be 4.5 cm., or slightly more than the mean between the maximum and minimum projected diameters of the actual focal area, which are 5.7 and 2.9 cm., respectively, as shown by the pinhole radiographs. This will produce a uniform penumbra all around, which will about average the maximum and minimum values of the oval focal spot.

It can be shown that under these conditions there is, for the 15 cm. field, a volume of full intensity of irradiation of 2,940 c.c., whether the diaphragm is at the skin or at 22 cm. With the diaphragm on the skin, there is an unavoidable penumbra of gradually decreasing intensity of 265 c.c. If the diaphragm is at 22 cm., there is an additional penumbra outside the unavoidable penumbra of 1,145 c.c. As the intensity of the applied radiation decreases from full intensity to zero, we may assume an average intensity of half value. Allowing for this by dividing the volumes of the penumbra by two, we get unavoid-

able excess irradiation due to penumbra when the diaphragm is at the skin, of 4.5 per cent, and avoidable excess irradiation when the diaphragm is at 22 cm., of 18.65 per cent (Fig. 4).

Likewise, it may be shown that the unavoidable penumbra irradiation for the 5 cm. field is 14.75 per cent, while the avoidable penumbra irradiation with the diaphragm at 22 cm. is 67.3 per cent (Fig. 4).

For comparison we have also considered the conditions at 200 kv., using the same hypothetical phantom and fields. As a 50 cm. target-skin distance is the most widely used at 200 kv., we have based our calculations on this, with the diaphragm at the skin level and at 11 cm. from the skin (Fig. 5). Pinhole radiographs (Fig. 3-B) show the actual size of our 200 kv. focal spot as projected in the direction of treatment to be about 2.7×1.2 cm., giving us a mean diameter of about 2 cm. The calculations are, therefore, based on a round focal area of 2 cm., placed perpendicular to the central ray. Under these con-

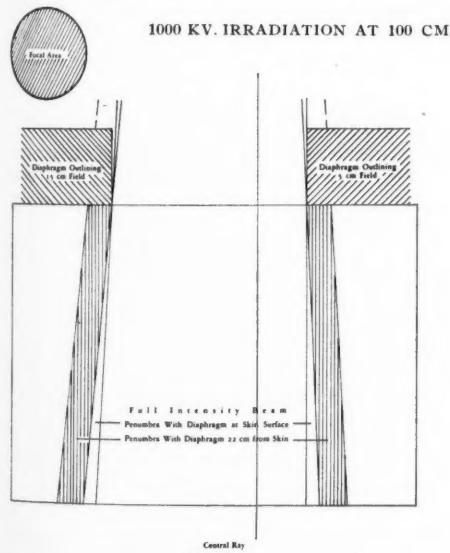


Fig. 4.

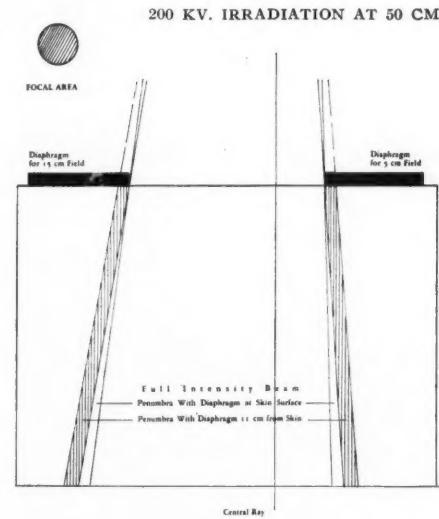


Fig. 5.

Fig. 4. Irradiation with 1,000 kv. at 100 cm. distance. Unavoidable penumbra—unshaded; avoidable penumbra—shaded.

Fig. 5. Irradiation with 200 kv. at 50 cm. distance.

ditions the excess penumbra irradiation with the diaphragm at 11 cm. is 7.88 per cent for a 15 cm. field and 25.33 per cent for a 5 cm. field.

CONCLUSIONS

It is shown by these considerations that the treatment area in deep x-ray therapy should always be defined by a diaphragm or cone as near the treatment area as possible. This applies especially to super-

voltage, if the focal area is of considerable size. It applies also, but is usually taken care of, in treatment at ordinary voltages. With supervoltage the conditions can practically be fulfilled only by the use of lead cones of proper size for each area treated, of sufficient ray-protective thickness for the voltage used. Reliance should not be placed on however thick lead diaphragms at a considerable distance from the treatment field. This is particularly important for small fields.

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ROENTGEN LOCALIZATION OF MYOCARDIAL DAMAGE RESULTING FROM CORONARY ARTERY DISEASE¹

By GEORGE LEVENE, M.D., F.A.C.R., and ROBERT M. LOWMAN, M.D., *Boston*

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CORONARY occlusion produces destructive changes in the myocardium, the degree and extent of damage depending on the size of the vessel occluded and the rapidity of obstruction. With sudden blocking of a coronary artery, there is early degeneration of the muscle fibers. According to Mallory and White (7), necrosis occurs within 24 hours. At this time there is an infiltration of polymorphonuclear leukocytes. About the second week there is cessation of leukocytic invasion and an appearance of phagocytes and new blood vessels. In the third week there is laying down of scar tissue, with invasion of fibroblasts and collagen. In the fourth week and thereafter, collagen steadily increases in amount and density and the earlier reaction subsides. In the second month, healing is, as a rule, complete, the site of infarction being marked by fibrous scar-tissue formation.

If the obstructed vessel is large, it may result in almost immediate death. The more common type, however, is a gradual, perhaps insidious, narrowing, which produces small progressive degenerative lesions in the heart muscle (Fig. 1). The changes, however, are compatible with life. In these cases, collateral circulation is established so that the heart may continue to function at a lower level of efficiency. This type of case is particularly apt to escape attention of the physician and patient, the symptoms frequently being vague, or suggestive of disease in the gastro-intestinal or biliary tracts.

The value of roentgen study in the diagnosis of coronary disease has already been established. The purpose of locali-

zation of the area of myocardial infarction tends to serve two functions: (1) it is conducive to more accurate diagnosis which should make possible earlier treatment of the disease; (2) it is of value in those cases selected for operation for the purpose of establishing new circulation to the heart.

Wearn (10) writes as follows:

"The right coronary artery (Fig. 2-A) arises from the anterior aortic sinus and emerges on the surface of the heart between the right auricle and conus arteriosus (2). Then, lying in the coronary sulcus, it runs to the right and downward where it rounds the acute margin to the diaphragmatic surface of the heart. It continues in the coronary sulcus from right to left to the region of the auricles



Fig. 1. Infarct in the anterior wall of the left ventricle (sectioned). Note the flattening of the contour in the region of infarction (arrows).

¹ Accepted for publication in October, 1939.

and ventricle where it turns to run down the interventricular groove as the posterior branch, and terminates near the apex. In its course, it gives off small branches to the left auricle. Usually, as it rounds the acute margin of the heart, it gives off a large branch called the marginal artery, which, in turn, gives off numerous branches to the right ventricular wall. In its course down the interventricular sulcus, the posterior descending branch gives off many large branches to the right ventricle, to the septum, and to that part of the left ventricle adjoining the septum near the apex. The posterior descending branch also gives off many deeper branches which plunge into the heart muscle where their arborization ends, for the most part in capillaries and sinusoids.

"The left coronary artery arises from the left aortic sinus and, immediately after emerging, divides into two main branches. The large anterior descending branch swings around to the left of the root of the pulmonary artery as far as the anterior interventricular groove, in which it descends to the apex and usually passes, still in the groove, around the apex to the diaphragmatic surface of the left ventricle, where it breaks up and disappears in the muscle wall. In its descent, the left anterior descending branch gives off numerous large lateral branches

to the left ventricle and the interventricular septum, as well as several branches to the right ventricle.

"The other main branch of the left coronary artery, the circumflex, takes a course to the left, emerges from beneath the left auricular appendage, and, in the auriculoventricular groove (coronary sulcus), swings around the obtuse margin to the posterior or diaphragmatic surface of the left ventricle. As it approaches the posterior interventricular groove, it makes a sudden turn toward the apex, and, as the posterior descending branch, arborizes to supply the posterior surface of the left ventricle. While occupying the auriculoventricular groove, the circumflex branch gives off small branches to the left auricle and larger branches to the left ventricle. The two main branches of the left coronary artery also give off deeper branches which find their way into the myocardium where they arborize to supply the capillary bed and the sinusoids."

Technic.—The procedure in use at the Massachusetts Memorial Hospitals consists of examination first in the frontal position, where observations are made pertaining to the contour of the heart, the

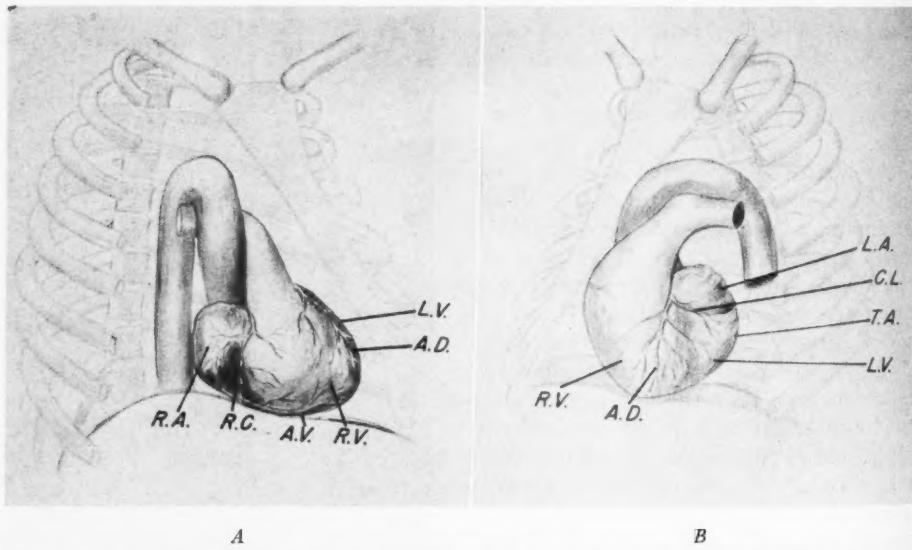


Fig. 2. (A) The heart in the right anterior oblique position. The patient is rotated so that the anterior wall of the heart adjacent to the interventricular septum forms the left border of the cardiac shadow (average 45°). (B) The heart in the left anterior oblique position. The patient is rotated so that the posterior surface of the left ventricle clears the shadow of the spine during deep inspiration (average 72°). R.A.: right auricle; R.C.: right coronary artery; A.V.: anterior ventricular branch; R.V.: right ventricle; A.D.: anterior descending branch; L.V.: left ventricle; T.A.: terminal arborizations of right coronary artery; C.L.: circumflex branch; L.A.: left auricle. (Modified from "Surface and Radiological Anatomy." Appleton, Hamilton, and Tchoperoff.)

amplitude of contractions of its component parts as well as of the vascular pedicle, the rate, and the rhythm. The typical contour in coronary artery disease (6) shows a loss of convexity of the left border of the heart (Figs. 3 and 4). It must be remembered, however, that some cases, particularly those of gradual onset, may show no recognizable alteration in the shape or size of the heart, so that this single observation is insufficient to warrant a definite conclusion. In acute cases, there is usually an increase in the transverse diameter of the heart due to relaxation of the myocardium as a result of diminished tone. These latter cases will also show a variable degree of congestive infiltration of the lungs.

The value of study of the amplitude of contractions will necessarily vary with the personal experience of the examiner.

The amplitude of contractions is generally diminished, the greatest change being observed in the area of greatest loss of convexity or, even, flattening of the left border of the heart. In patients who have had hypertension, the changes may be less well marked (5). There may be sufficient ventricular hypertrophy to prevent sagging of the wall. In hypertension, moreover, the amplitude of pulsations is usually increased and while the advent of thrombosis and infarction results in diminished activity of the heart muscle with contractions of smaller amplitude, they may still be of approximately normal range. Such contractions, however, are too weak for a hypertensive heart and are, therefore, regarded as inferential evidence of myocardial impairment.

The patient is next rotated into the right anterior oblique position, between

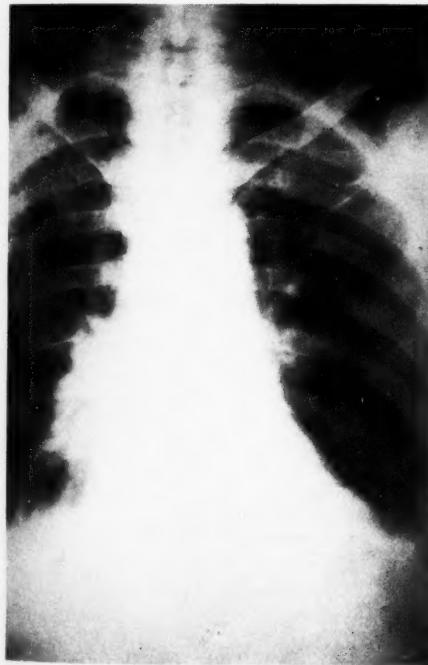


Fig. 3.

Fig. 3. Coronary thrombosis, with infarction of the anterior wall of the left ventricle. Note the loss of convexity of the left border and pulmonary congestion.

Fig. 4. Kymogram showing greatly diminished activity of the left ventricle in the presence of infarction (brackets).



Fig. 4.

40 and 45° (Fig. 2-A). The amount of rotation depends on the size of the heart and usually need not be as much as is required for study of the retrocardiac space. Careful scrutiny is made of the *presenting left border* of the cardiac silhouette. In this position, the amplitude of contractions is normally approximately three millimeters. In the presence of infarction, the amplitude is diminished. Sometimes a localized area may appear to be perfectly stationary while the patient suspends respiration. This position affords a view of the anterior surface of the heart, including those portions of the right and left ventricles adjacent to the interventricular septum. These regions, it will be recalled, are supplied by the anterior descending branch of the left coronary artery and the anterior ventricular branch of the right coronary artery. Infarctions in this region are referred to as "anterior" (Figs. 5, 6, and 7).

The patient is then rotated into the left anterior oblique position, the average being about 72° (Fig. 2-B). In cases in which the heart is small, a satisfactory view may be obtained with as little as 65-degree rotation; if the left ventricle is considerably hypertrophied and dilated (as may occur in chronic hypertension), rotation of more than 72° is required. The optimum position for study is one which will allow clear visualization of the posterior aspect of the left ventricle unobstructed by the shadow of the thoracic spine (the heart is to the patient's right of the spine) during a deep inspiration. This region normally shows the greatest activity of the entire cardiovascular silhouette, the range of amplitude varying between seven and ten millimeters or even more. When there is an infarct in the posterior wall of the left ventricle, the amplitude is materially diminished. It may be well to emphasize that the force of

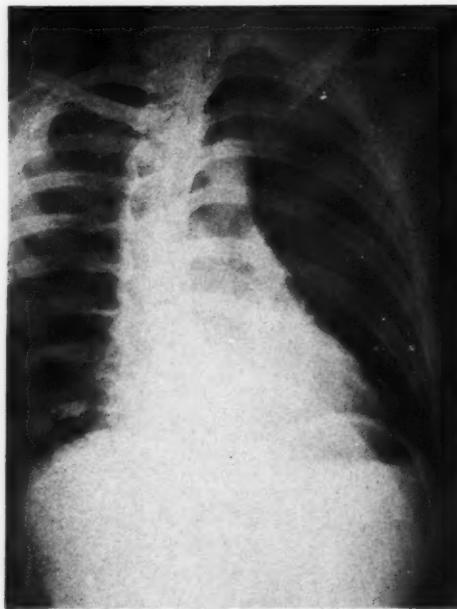


Fig. 5.

Fig. 5. Roentgenogram in the right anterior oblique position showing the most common site of infarction (brackets).

Fig. 6. Kymogram in the right anterior oblique position showing marked diminution in the amplitude of contractions in a case of anterior wall infarction (brackets). Normal average amplitude in this region is about three or four millimeters.

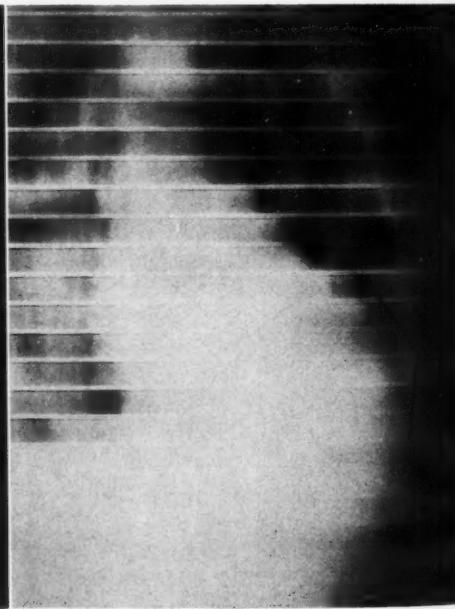


Fig. 6.

beat in this position (Fig. 8) is so much greater than that observed in the frontal view that, even when diminished, it may

Even in anterior infarctions, the activity of the posterior wall of the left ventricle is somewhat diminished. When the

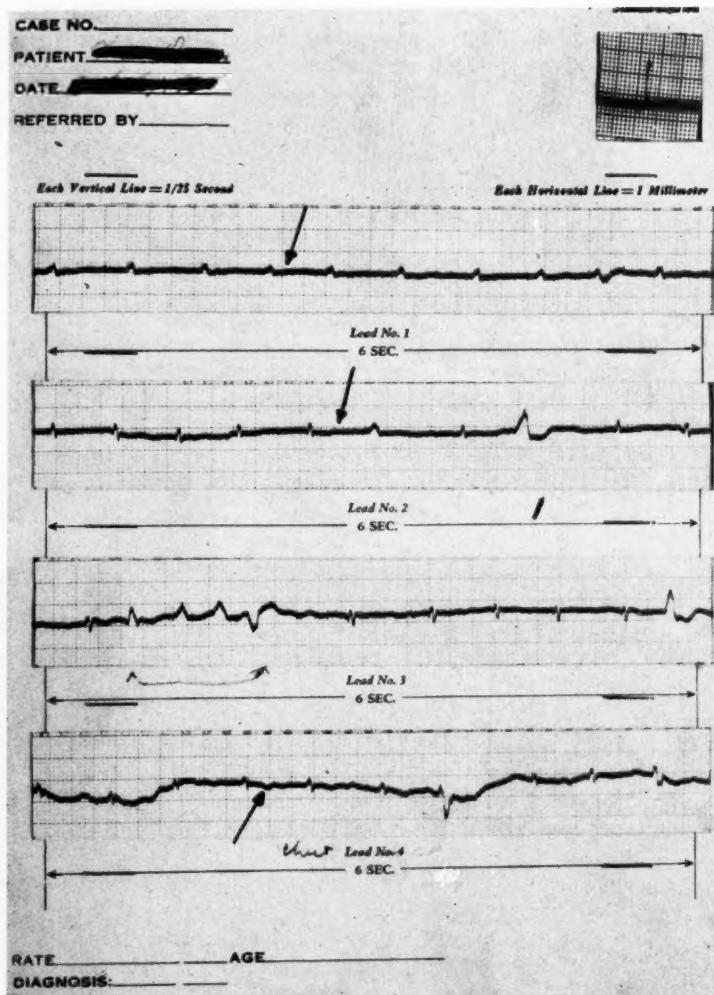


Fig. 7. Typical electrocardiogram in anterior wall infarction characterized by inversion of T_{CP} (chest lead)—lowest arrow, T_1 and T_2 almost flat.

appear to the inexperienced examiner to be fairly strong. It is, therefore, profitable to examine a number of normal cases in order to record a mental image of amplitude of contractions in the several positions. Infarctions in this region are referred to as "posterior" (Figs. 9, 10, and 11).

infarct involves the posterior wall, movement of the area affected is not over three or four millimeters. It may even appear to be stationary. If there is associated heart block, there is probable infarction of the interventricular septum as well (Figs. 12, 13, and 14).

While the rate of cardiac contractions is

commonly of little importance, it may occasionally be a clue to the presence of degenerative changes in the heart muscle. We have found the normal average rate during fluoroscopic examination to be 100 per minute, probably because of appre-

hensiveness due to the surroundings. A rate of 60 or less is, therefore, suspicious and, if we are unable to detect the presence of arrhythmia during fluoroscopic examination, we feel that this slow rate is sufficient indication for electrocardiographic study.

TABLE I.—ANALYSIS OF CASES OF INFARCTION LOCALIZED BY X-RAY, IN WHICH ELECTROCARDIOGRAMS AND AUTOPSY FINDINGS WERE AVAILABLE

Group	No.	Electrocardiogram in Agreement with X-ray	Autopsy in Agreement with Electrocardiogram	Autopsy in Agreement with X-ray
Anterior Infarction	21	10 (7 cases not localized 2 cases reported negative case reported bundle-branch block 1 case reported anterior and posterior)	10 (50%)	19 (85.7%) (1 case reported myocardial scarring and fibrosis, most marked anterior wall, left ventricle 1 case reported anterior and posterior 1 case reported myocardial edema and degeneration, coronary sclerosis)
Posterior Infarction	2	2	2 (100%)	2 (100%)
Anterior and Posterior Infarction	5	5 (2 cases reported anterior 1 case reported posterior 2 cases reported bundle-branch block)	5 (80%)	5 (100%) (3 cases reported anterior 1 case reported posterior)
Septal Infarction (included in other groups)	4	4	4 (100%)	4 (100%)
Total	31	15	19 (54.8%)	24 (77.4%)

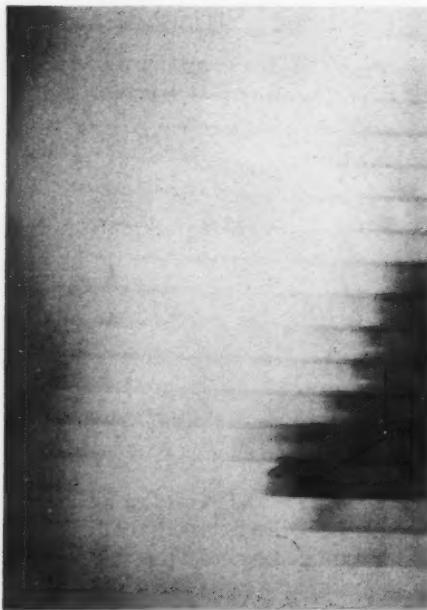


Fig. 8. Kymogram in the left anterior oblique position (72°). This film is shown to emphasize the magnitude of normal contractions of the posterior wall of the left ventricle (usually 10 mm. or more).

The presence of heart block (11) is strong presumptive evidence of coronary artery disease (Fig. 14).

In a series of 38 cases studied roentgenoscopically in which electrocardiograms and postmortem examinations were also available, 21 were reported as having infarction of the anterior wall (Table I). On autopsy, 18 of these were found to be anterior infarcts; one case showed anterior and posterior infarction; one case showed myocardial scarring and fibrosis—more marked on the anterior wall of the left ventricle; one case presented myocardial degeneration with marked coronary sclerosis but no apparent infarct.

Confirmatory electrocardiograms were obtained in only 10 of these 21 cases. One case reported as anterior was found at autopsy to have anterior and posterior infarction; two cases reported as normal were found at necropsy to have anterior infarcts; of seven cases not localized, there were five anterior wall infarcts, one case of myocardial scarring and fibrosis,

more marked on the anterior wall of the left ventricle, and one case of myocardial degeneration with marked coronary sclerosis but no apparent infarct. One case of bundle-branch block, which could not be localized by the electrocardiogram, was an anterior wall lesion. One case reported to be anterior and posterior was found to be anterior only.

Two cases of the series were reported as showing infarction of the posterior wall by roentgenoscopic study (Table I). The electrocardiograms were in agreement and both were confirmed by autopsy.

In eight cases we reported infarction of the anterior and posterior walls of the heart (Table I). Four of these were confirmed at necropsy. Three others showed infarcts in only the anterior wall and one in only the posterior wall. Electrocardiograms of these eight patients were fully in agreement in only three instances. Of two cases reported as anterior, one was

confirmed at necropsy, one was found to be both anterior and posterior. One case reported as posterior was confirmed by the pathologist. In two cases, localization was not possible because of bundle-branch block.

In three cases no localization was attempted by roentgenoscopic examination. Electrocardiograms showed one of these as anterior; this was confirmed by autopsy. Two cases not localized were found to be posterior infarcts (Table III).

Two cases of the series were reported on fluoroscopic examination as hypertension, with failure. One of these was reported by the electrocardiogram as hypertension, myocardial impairment, probable anterior infarction, and was found at necropsy to be generalized myocardial and perivascular fibrosis and hypertrophied myocardium. The other case was reported by the electrocardiogram as coronary thrombosis, no localization, and hy-

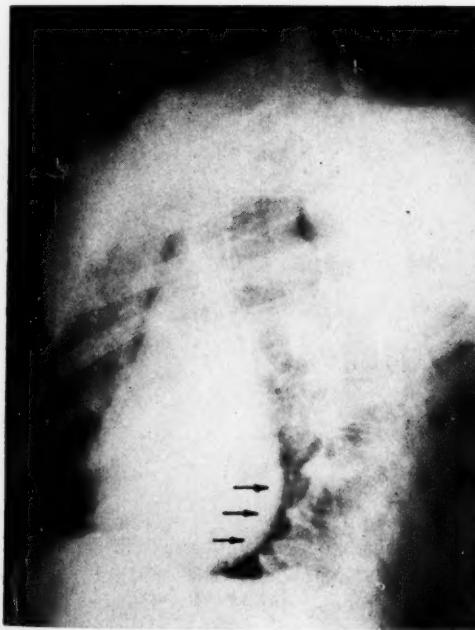


Fig. 9.



Fig. 10.

Fig. 9. Roentgenogram in the left anterior oblique position showing common sites of posterior wall infarction (arrows).

Fig. 10. Kymogram in the left anterior oblique position showing marked inactivity of the posterior wall of the left ventricle in a case of posterior wall infarction (cf. Figure 8).

pertension; this was found at autopsy to be coronary sclerosis and myocardial fibrosis (Table II).

of cardiac infarction were based on roentgenoscopic examination alone. No knowledge was had of the history or physical

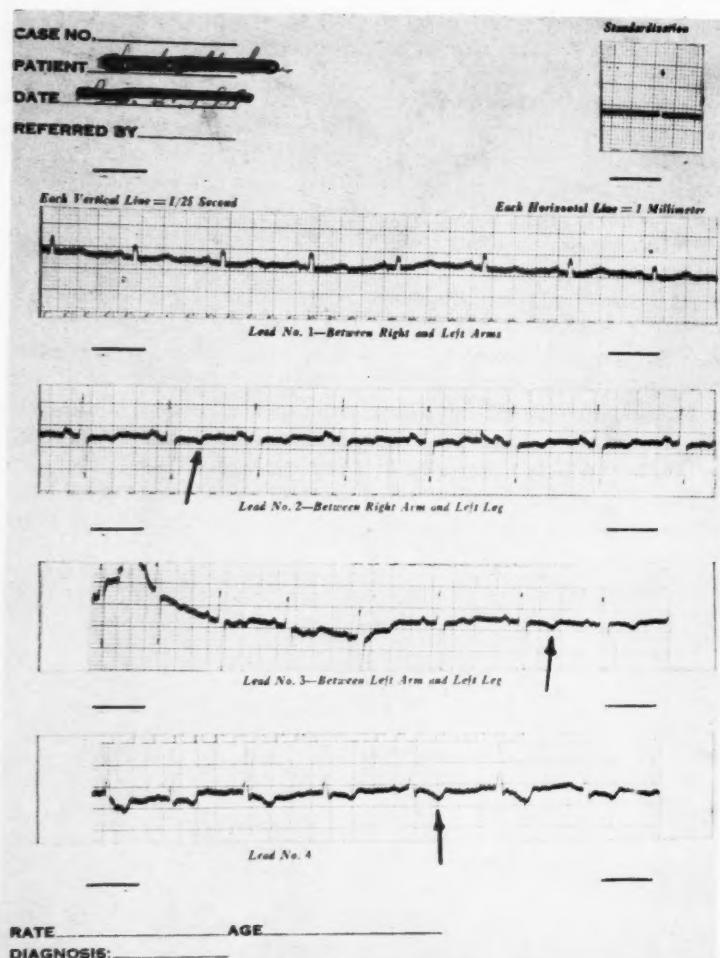


Fig. 11. Typical electrocardiogram in posterior wall infarction, characterized by inversion of T_2 and T_3 (upper two arrows).

One case, reported as negative roentgenoscopically, was found to have myocardial and perivascular scarring; the electrocardiogram had reported coronary thrombosis, with no localization (Table II).

DISCUSSION

In this series, diagnosis and localization

findings. In many cases diagnosis was established before electrocardiograms were taken. It would, therefore, appear that roentgenoscopic study is an important means for the recognition of coronary artery disease, particularly in view of the fact that certain limitations of the electrocardiogram are not experienced by the roentgenologist and that the history, which

is generally regarded as another important diagnostic feature, is frequently unreliable. In the early stages of coronary thrombosis of any degree of severity, the electrocardiogram may be negative (8) and serial tracings are frequently required before typical diagnostic changes develop. The administration of certain drugs, such as digitalis, quinidine, or morphine, may alter the electrical wave form sufficiently to make recognition of coronary disease impossible (1, 9).

Moreover, even in cases of severe infarction, the electrocardiogram may return to normal in a comparatively short time and there are some in which the electrocardiogram remains normal throughout (2).

In our experience, none of these factors was of importance in roentgenoscopic examination of the heart. In a series of cases to be published shortly, we have been able to recognize the presence of

coronary artery disease before serial electrocardiograms became diagnostic, in periods varying from one day to several months. Digitalis, quinidine, and morphine seem to have no effect on the roentgenoscopic appearance of the heart. While the rate may be slowed and contractions be somewhat stronger, the diagnostic criteria, *localized* change in contour and *localized* diminution in the amplitude of contractions, are not masked.

After subsidence of an acute attack of coronary thrombosis, the electrocardiogram frequently tends to return to normal. While we are not prepared to give definite statistics, we have found the earliest disappearance of roentgenoscopic signs to be approximately six months. In some cases definite evidence has remained for almost three years.

Concerning the fallibility of history, Kennedy (4), in a review of 200 autopsied cases, mentions the absence of a history

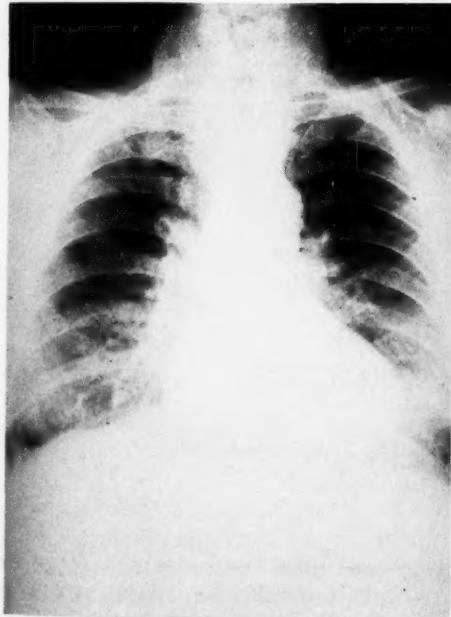


Fig. 12.

Fig. 12. Roentgenogram in a case of septal infarction associated with lesions of the anterior and posterior wall. Diagnosis, however, was based on fluoroscopic examination (*cf.* Figure 13).

Fig. 13. Kymogram of same case as that shown in Figure 12, showing auricular fibrillation and heart block. The latter is presumptive evidence of septal infarction, if digitalis effect is excluded.



Fig. 13.

of pain in 22 per cent of "old" and in 4 per cent of "recent" cases. This observation has been amply confirmed by others (3).

component of the heart's movement; vertical motion is not registered. Since the greatest movement of the apex is in a

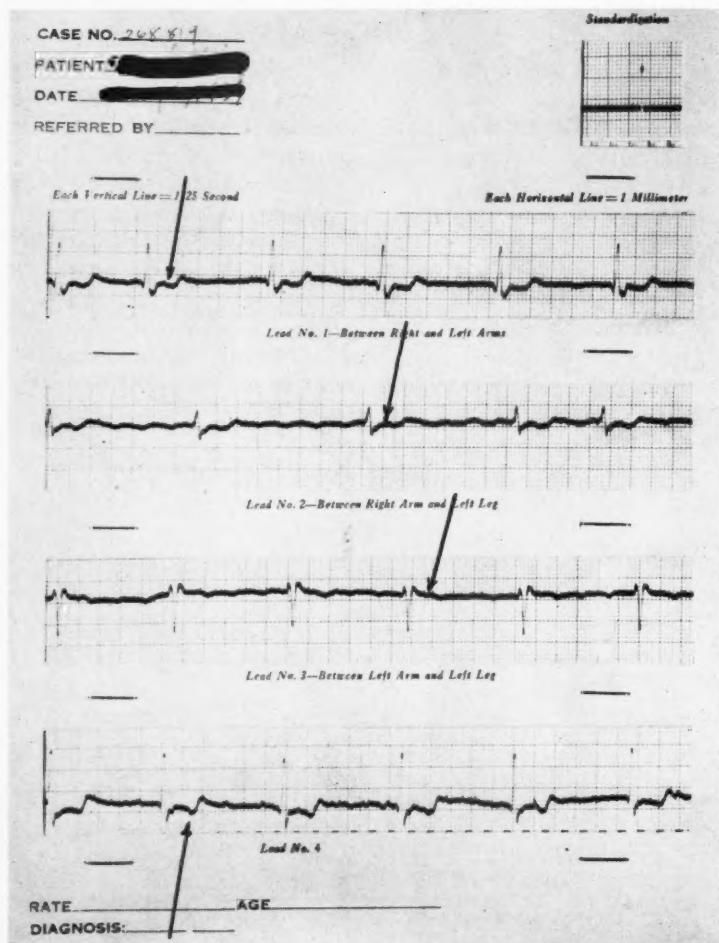


Fig. 14. Electrocardiogram showing auricular fibrillation and heart block. Note S-T_{1,2} and CF₄ depressed, S-T₃ slightly elevated with T₃ slightly inverted. Ventricular rate of 50 with auricular fibrillation indicates block. (Digitalis effect has been excluded.) Same case as that shown in Figures 12 and 13.

Kymograms are useful to record alterations of contraction of the heart, but while such records are made in many of our cases, greater dependence is placed upon roentgenoscopic appearance. It must be remembered that the ordinary horizontal slit kymograph records only the lateral

cephalocaudad axis, kymograms of even normal hearts frequently show an absence of excursion wave in this region. More accurate evaluation of the component parts of the cardiovascular shadow is, therefore, obtained by direct roentgenoscopic inspection.

CONCLUSIONS

Roentgen diagnosis of coronary artery disease compares favorably with any other

cent. We believe the value of roentgen study lies not so much in confirming electrocardiographic or clinical examination

TABLE II.—X-RAY, ELECTROCARDIOGRAM, AND AUTOPSY FINDINGS IN MISCELLANEOUS GROUP

No. of Cases	X-ray	Electrocardiogram	Autopsy
1	Hypertension with failure	Hypertension, myocardial impairment, probable anterior infarction	Generalized myocardial and perivascular fibrosis, hypertrophied myocardium
1	Hypertension with failure	Coronary thrombosis, no localization, hypertension	Coronary sclerosis, myocardial fibrosis
1	Anterior infarction	Coronary thrombosis, no localization	Myocardial scarring and fibrosis, most marked anterior wall, left ventricle
1	Anterior infarction	Coronary thrombosis, no localization	Coronary sclerosis, myocardial edema and degeneration
1	No evidence of organic heart disease	Coronary thrombosis, no localization	Myocardial and perivascular scarring

TABLE III.—ANALYSIS OF 33 CASES OF CORONARY ARTERY DISEASE LOCALIZED AT AUTOPSY AND IN WHICH X-RAY AND ELECTROCARDIOGRAM FINDINGS WERE AVAILABLE

Group	No.	Electrocardiogram in Agreement with Autopsy	X-ray in Agreement with Autopsy
Anterior Infarction	23	12 (52.2%) (5 cases not localized 1 case reported anterior and posterior 2 cases reported negative 3 cases reported bundle-branch block)	18 (78.3%) (1 case not localized 3 cases reported anterior and posterior 1 case reported hypertension)
Posterior Infarction	5	3 (60%) (2 cases not localized)	2 (40%) (2 cases not localized 1 case reported anterior and posterior)
Anterior and Posterior Infarction	5	3 (60%) (2 cases reported anterior)	4 (80%) (1 case reported anterior)
Septal Infarction (included in other groups)	6	6 (100%)	4 (66.7%)
Total	33	18 (54.5%)	24 (72.7%)

available method. Validity of the diagnostic criteria is strengthened by ability to localize by these changes the area of involved myocardium. Accuracy of roentgen diagnosis of coronary artery disease as checked by autopsy in 38 cases is 89.5 per cent and accuracy of electrocardiographic diagnosis, 94.7 per cent. Of 33 cases localized at autopsy, roentgen localization was fully in agreement in 72.7 per cent and electrocardiographic diagnosis in 54.5 per

as in its ability to detect coronary artery disease with reasonable accuracy when changes appreciable by other methods of examination have not as yet developed, or have disappeared, or are masked by drugs or other factors.

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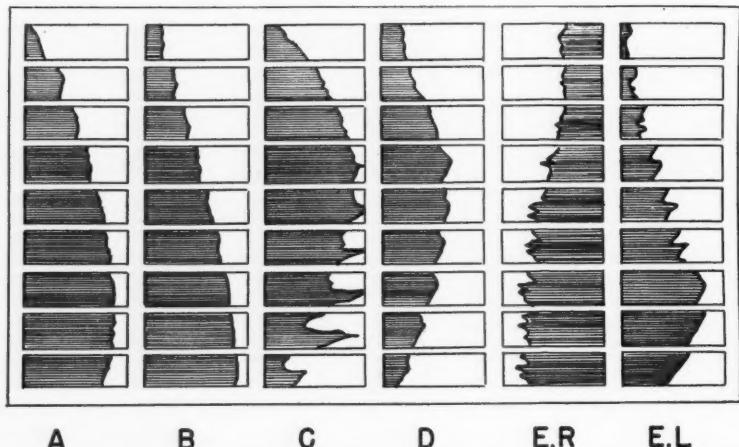


Fig. 15. Tracings from kymograms showing details of contraction waves: *A*, Figure 4; *B*, Figure 6; *C*, Figure 8; *D*, Figure 10. *E.R* and *E.L*, right and left borders of Figure 13 showing auricular fibrillation and heart block.

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ANEURYSM OF THE SPLENIC ARTERY¹

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ANEURYSM of the splenic artery is uncommon and difficult to diagnose during life. Although many small aneurysms of the splenic artery are discovered during postmortem examinations, others may have important clinical significance if rupture takes place or if their size becomes great enough to cause disturbing symptoms by pressure on neighboring organs. Numerous cases of rupture of the aneurysm have been reported, either as a complication of pregnancy or spontaneously. Review of the literature shows that less than 100 cases have been recorded since the earliest found published report in 1847 (Crisp, 5). Anderson and Gray (1), in 1929, reported a case and summarized briefly 58 cases of aneurysm of the splenic artery collected from the literature. With the exception of a few instances reported in recent years, the diagnosis was usually established at postmortem examination and, occasionally, at operation. Up to the present time, approximately 93 cases have been found in the literature. Ten cases were diagnosed during life and two pre-operatively.

Surgical removal of aneurysms of the splenic artery has been reported by Winckler (21), Mulley (17), Davis (7), Goullioud (10), Brockman (4), Lower and Farrell (15), Lindboe (14), and Parsons (18). Winckler stated in his article that Seltén was the first to operate on such a case with success. In some instances, the spleen was removed together with the aneurysm. Marshall (16) operated on a patient with an aneurysm produced by a bullet wound and was able to produce a cure by proximal and distal ligation.

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Hoegler (11) was the first to diagnose a case of aneurysm of the splenic artery on the basis of signs and symptoms. Roentgen studies revealed calcium deposits in the lesion over which a clear swishing, systolic murmur was audible. The reports of Davis, Goullioud, and Lindboe also contained roentgen findings of significance, Lindboe's patient being operated on successfully on the basis of the roentgen diagnosis of calcified aneurysm of the splenic artery.

CASE REPORTS

Case 1. E. B. 59-year-old female, was admitted to Cleveland City Hospital, on June 7, 1937, complaining of pain starting in the neck and radiating downward to both shoulders. There was a weight loss of 30 pounds during the six months prior to admission. In addition to a progressive feeling of weakness, she complained of intestinal gas, belching, and inability to eat cabbage and fried foods. Constipation was frequent, being relieved only by cathartics. Mild nocturia had been present for many years. Menstruation began at the age of 16, was always regular, and of four days' duration. Menopause took place at the age of 49. The patient had been married for the past 30 years. Two children were living and well and two had died during infancy. Two or three miscarriages had occurred. The patient's father died of carcinoma of the bladder.

Examination revealed a well developed and well nourished apathetic female, with good color. The heart was slightly enlarged to the left and on auscultation presented a soft-blowing systolic murmur over the aortic area, probably due to arteriosclerosis. The palpable vessels were mar-

kedly arteriosclerotic. The blood pressure was 175/105.

Palpation of the abdomen revealed in

July 3, 1937, examination of the chest showed no evidence of a pathologic process. Lateral view of the abdomen showed

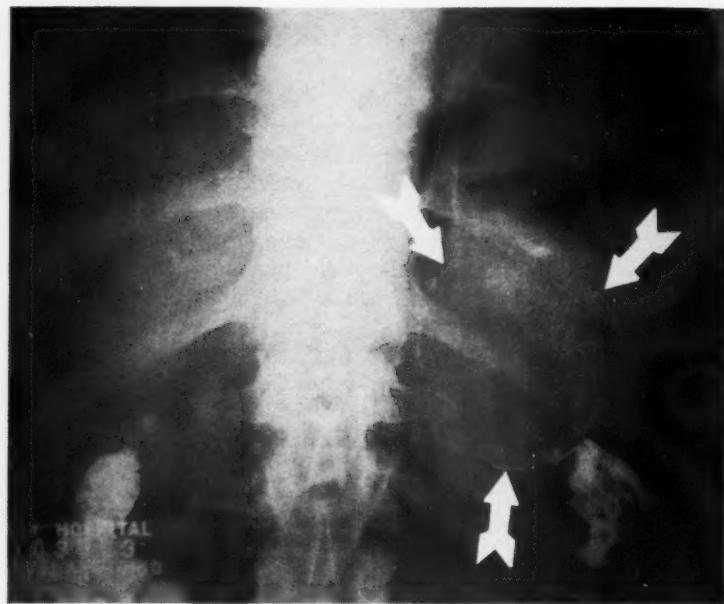


Fig. 1-A. Anteroposterior roentgenogram showing a large round calcified aneurysm of the splenic artery in the left upper abdomen, measuring 9 cm. in diameter. Calcified gallstones are present in the right upper abdomen.

the left hypochondrium a firm mass which was slightly tender, the margins of which were regular and rounded. There was no ascites, rigidity, or spasm. The mass moved with respiration.

Roentgen studies of the colon, made on July 1, 1937, showed no evidence of abnormality in the large bowel. In the upper right abdominal quadrant opaque shadows were present, due to a large cluster of gallstones. In the upper left quadrant superior to the splenic flexure of the colon, a large circular area of dense calcification measuring 9 cm. in diameter was visible (Figs. 1-A and 3). The central portion of this shadow was composed of faintly mottled, irregular areas of calcification and the periphery of "pencil-like" density. This large calcium deposit was situated at the level of the first lumbar vertebra, about 2 cm. from its lateral border. On

the previously described calcific mass to be spherical with its center situated at the anterior border of the first lumbar vertebra (Fig. 1-B). On July 8, 1937, examination of the stomach and small intestines, by means of contrast material, showed no organic lesion in the gastrointestinal tract. The spherical area of calcification was situated on the postero-medial aspect of the stomach (Figs. 2-A and 2-B). The possibility that this calcification might be situated in the cortex of the left kidney indicated that urologic studies should be done. On July 14, 1937, retrograde urograms showed no abnormalities in the urinary tract. The mass of calcification was situated above the level of the left kidney (Fig. 4). These findings suggested the possibility of the presence of a calcified echinococcus cyst of the left lobe of the liver.

Laboratory Findings.—On June 29 and Aug. 6, 1937, the blood urea nitrogen was 6.3 and 9.5 mg. per 100 c.c., respectively. Kline's diagnostic and exclusion tests were negative.

Dr. J. T. Stephens, intern, recorded on the patient's chart that palpation of the mass in the left upper abdominal quadrant gave a pulsating sensation and that a definite bruit was audible on auscultation. Although the mass felt as though it were contiguous with the liver, the bruit was suggestive of aneurysm, possibly of the splenic artery.

Because of the patient's symptoms and the presence of the large calcium deposit in the upper left abdomen, operative intervention was considered advisable.

Operation.—On Aug. 2, 1937, the abdomen was entered through an upper left rectus incision. The spleen was found to be about twice the normal size. The gastrocolic mesentery was opened transversely, the mass explored and found to be about 10 cm. in diameter. Expansile pulsation and a coarse thrill were palpated. Due to the dense adhesions of the mass to the pancreas and the posterior abdominal wall, it was considered unwise to attempt extirpation and splenectomy. The proximal trunk of the splenic artery could not be satisfactorily exposed through the gastrocolic omentum. An incision was, therefore, made through the gastrohepatic ligament which afforded excellent exposure of the celiac axis and its branches. It was found that the aneurysm was about 6 cm. from the axis. The artery was completely covered by the upper border of the pancreas. It was isolated for a distance of 3 cm. at a point 2 cm. from the axis. At this point it was determined that occlusion of the artery caused a cessation of the thrill and the pulsation in the aneurysm. The artery was then doubly ligated in continuity by two ligatures of umbilical tape. It was considered unsafe to divide the artery because the stump would have been too short, especially in view of the calcification. The openings in the gastrohepatic and gastrocolic mesenteries were

closed and the operation concluded. On Aug. 1, 1938, roentgen studies of the abdomen showed the calcified aneurysm



Fig. 1-B. Lateral view of a calcified aneurysm, showing its posterior position at levels of *T-12*, *L-1*, and *L-2*. The superior margin is just below the level of the diaphragm.

of the splenic artery to have regressed about 1 cm. in diameter since the last examination. Measurements were $8 \times 8 \times 7$ cm. Two years following operation, on Aug. 9, 1939, further roentgen studies of the abdomen showed a continued regression in size of the calcified aneurysm. Measurements were $7 \times 5 \times 6$ cm. (Figs. 5-A and 5-B). Clinical examination at this time revealed the patient to be symptom-free. The tumor could not be palpated and a bruit was not audible.

Case 2. C. S., 65-year-old white male, was referred by E. E. Beard, M.D., for roentgen examination of the spine because the patient complained of low back pain. He had been a severe diabetic for a period of 15 years, being managed under a strict dietetic and insulin régime. A moderate degree of arteriosclerosis was present in the palpable vessels. The chest and heart showed no abnormalities. There was no

evidence of renal disease. On Jan. 18, 1939, roentgen examination of the lumbar spine revealed a wedge-shaped appearance to the body of the fourth lumbar vertebra with a bony bridge-work between the anterior margins of the third and fourth vertebral bodies with moderate widening of the intervertebral space. These findings were diagnostic of an old healed compression fracture of the body of the fourth lumbar vertebra. In addition, a spherical calcified mass, somewhat oval in shape and measuring approximately 4 cm. in diameter, was visible in the soft tissues of the upper left abdominal quadrant just below the level of the twelfth rib at its outer extremity and situated posteriorly. Its center was opposite the level of the arch of the second lumbar vertebra. The periphery of the calcific deposit appeared extremely dense and of "pencil-line" thickness (1 mm.), being interrupted for a distance of 0.5 cm. at the junction of the

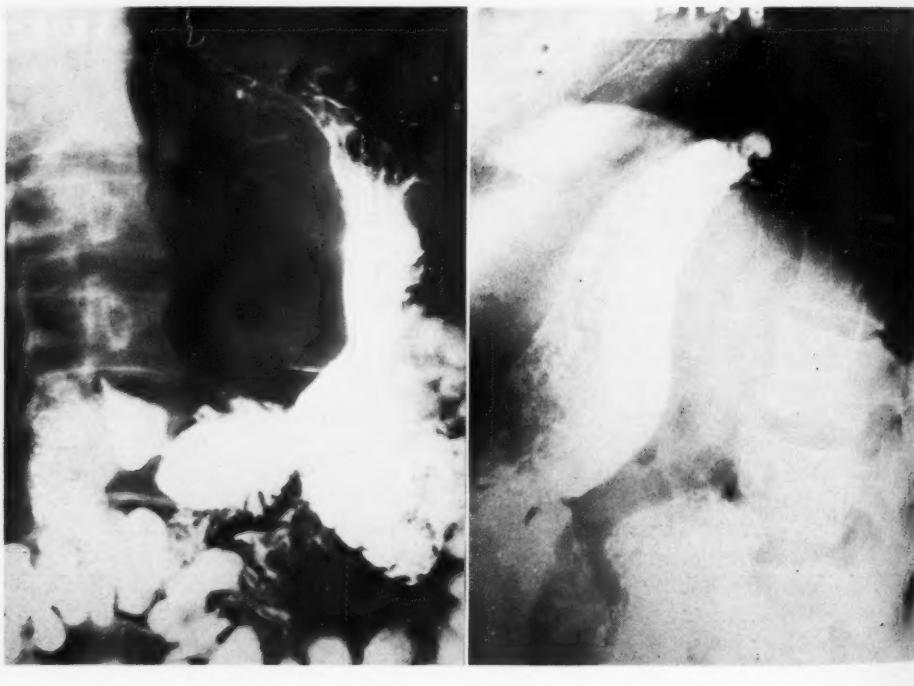
upper and middle thirds, giving the appearance of a cracked egg-shell. The central portion of this mass was composed of faintly mottled calcification (Fig. 6). Further roentgen studies with contrast material in the gastro-intestinal tract showed the calcium mass to be situated posterior to the stomach and splenic flexure of the colon. Urograms were not made. Auscultation over the mass failed to disclose a murmur. Blood Wassermann and Kline tests were not done.

The diagnosis was calcified aneurysm of the splenic artery.

Recently the patient developed an adenocarcinoma of the sigmoid portion of the colon for which a combined abdominal and perineal resection was performed.

INCIDENCE

Schroeder (20) states that v. Schroetter found in 19,300 autopsies 200 aneurysms, four of which were in the splenic artery.



Figs. 2-A and 2-B. Anteroposterior and lateral projections of the upper abdomen, showing medial and posterior relations of a calcified aneurysm of the splenic artery to the barium-filled stomach.

Müller found in 10,360 autopsies 183 aneurysms, nine of which were of the splenic artery. Bosdorf found in 3,108 autopsies 93 aneurysms, seven of which were of the splenic artery. Emmerich found in 8,669 autopsies 58 aneurysms of which one was of the splenic artery. Garland (8) found only three aneurysms of the splenic artery in over 4,100 autopsies at the Massachusetts General Hospital. In 12,894 autopsies at Cleveland City Hospital, only four instances of aneurysm of the splenic artery have been encountered. In these four cases the aneurysm was an incidental finding and the size varied from 1.3 to 5 cm. in diameter. Thus, in some 58,000 collected cases coming to autopsy, the percentage of aneurysm of the splenic artery is approximately 0.05. Schroeder's collected figures indicate that the percentage of aneurysms in general is 1.26.

SYMPTOMS AND SIGNS

The symptoms of aneurysm of the splenic artery vary greatly and are misleading in that they are often referred to other organs. Many aneurysms are asymptomatic until the time of rupture or at least the symptoms are so mild as to cause the patient little concern. Certain patients, however, present history and findings which, if properly interpreted, will lead to the correct diagnosis and treatment before rupture. A discussion of the symptomatology may be carried out under two headings: (1) before rupture, (2) after rupture. In the consideration of this diagnosis it is well to bear in mind Hunt's (12) finding that 16 per cent occur under the age of 35, long before the age at which aneurysms of other arteries are usually encountered. Lower and Farrell reported a



Fig. 3.

Fig. 3. Colon study showing a calcified aneurysm to be situated superior to the splenic flexure of colon. Gallstones are clearly visualized on right.

Fig. 4. Excretory urogram showing an aneurysm above the level of the left kidney, excluding involvement of the renal artery.



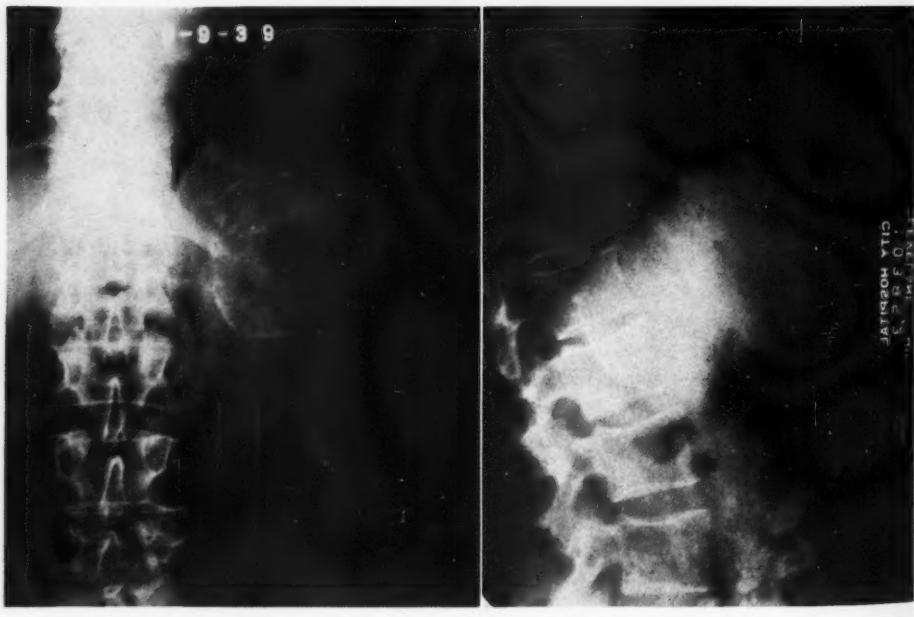
Fig. 4.

case of a boy aged 16, probably the youngest patient on record.

Before Rupture.—Symptoms vary from the mildest type of epigastric distress or dyspepsia to the violent paroxysms of epigastric pain presented by Lower and Farrell's patient. Occasionally a splenic enlargement or an epigastric tumor may be detected in a routine physical examination of an individual who has no complaints referable to this region. Digestive disturbances are frequent and may simulate those of gastric or duodenal ulcer. Gastrointestinal hemorrhage appearing as hematemesis or melena is not infrequent. The varying degrees of secondary anemia encountered no doubt originate in this loss of blood. Dyspepsia and pain suggesting gall-bladder disease are occasionally present. Pain in the epigastrium or left hypochondrium, of variable intensity aggravated by exercise and exertion and not associated with meals or hemorrhage, is sometimes encountered. Attention has been directed by some authors to the oc-

currence of pancreatic insufficiency, believed to be due to pressure on the pancreas and manifested by the presence of undigested fat in the stool.

After Rupture.—Rupture may simulate almost any acute disaster occurring within the abdomen. Before operation, it has been considered a perforated ulcer, acute pancreatic necrosis, mesenteric infarction, intestinal obstruction, ectopic pregnancy, and concealed hemorrhage within a pregnant uterus. It has complicated pregnancy in at least eight of the recorded cases. Cesarean sections, hysterectomies, and salpingectomies have been performed when complications of gestation were believed to be the cause of the presenting signs and symptoms. The picture generally presented is that of a patient who has been seized with sudden, severe epigastric or left hypochondriac pain which is promptly referred to the left shoulder, followed by persistent vomiting and varying degrees of shock. The pain is usually confined to the upper abdomen for a short



Figs. 5-A and 5-B. Roentgenograms made two years after ligation of the splenic artery proximal to the aneurysm show the lesions to have regressed in size about 2 cm. Calcification is somewhat denser.

time until leakage through the foramen of Winslow occurs. The pain then travels down the right flank to the iliac fossa. From this point it becomes generalized. Rupture has been reported to have occurred after paracentesis abdominis (8).

Brockman (4) and Parsons (18) have called attention to the fact that rupture not infrequently occurs in two phases. The first is ushered in by a more or less severe pain in the upper abdomen which subsides after a short time without giving evidence of a serious loss of blood. This they consider as being due to a rather small hemorrhage into the retroperitoneal space or into the lesser sac which is arrested rather quickly by clot formation. The second rupture occurs any time from 5 to 14 days later. The symptoms progress at a rapid rate to a fatal termination unless recognized. During the interval between the primary and secondary rupture, the patient is usually symptom-free and may present little on examination. It should be borne in mind that rupture into the gastro-intestinal tract may occur with severe or fatal hemorrhage without intraperitoneal hemorrhage. This occurred in 5 of the 40 cases collected by Baumgartner and Thomas (3). Rupture into the splenic vein occurred twice in this series. In the event of intraperitoneal rupture varying degrees of tenderness and muscle rigidity are encountered. Demonstrable free fluid is present in more advanced cases.

This array of symptoms suggests the difficulties encountered in the diagnosis both before and at operation. Perhaps the most important suggestion that can be made is that the possibility of this aneurysm be kept in mind whenever a tumor is encountered in the epigastrium or left hypochondrium, especially if it is accompanied by demonstrable splenic enlargement. Once it is considered, careful palpation for expansile pulsation and auscultation for a bruit should follow. Differentiation from an aneurysm of the abdominal aorta or from a tumor transmitting the pulsation of the aorta may not be possible before laparotomy. In patients in whom a

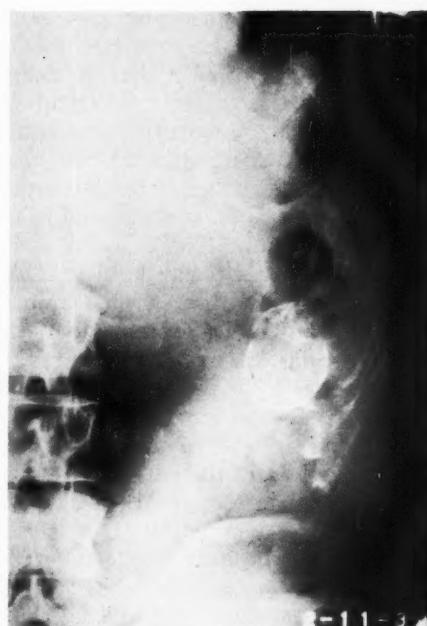


Fig. 6. Anteroposterior view of a spherical calcium deposit in the upper left abdomen in an unproved case of aneurysm of the splenic artery.

tumor cannot be palpated, a bruit may be heard upon abdominal auscultation. Brockman was able to hear a bruit and suspect the diagnosis in his patient by following his invariable practice of abdominal auscultation in all acute cases coming under his observation. Rupture had occurred in his patient, the symptoms simulating intestinal obstruction. Recovery followed extirpation of the spleen and aneurysm.

Unfortunately it is not always an aneurysm of the splenic artery that gives this picture. Several cases of aneurysms of the hepatic, renal, mesenteric, and large abdominal arteries are on record. Surgical exploration in cases of abdominal hemorrhage should include examination of the splenic artery.

Roentgen Aspects.—When calcification is present in its walls, aneurysm of the splenic artery lends itself readily to diagnosis by roentgen examination. The calcium deposits form an oval or circular shadow of

increased density in the upper segment of the left side of the abdomen (Golden, 9). The periphery is usually sharply delineated, whereas the central portion of the mass presents a mottled appearance (Dahm, 6). Not infrequently, the outer rim of the calcification may be interrupted in one or more places, as was noted in the authors' two cases. The exact situation of the calcific deposit may be determined by gastro-intestinal studies with contrast material and by either excretory or retrograde urograms. The lesion occupies a position posterior or posteromedial to the pars media of the stomach, above the splenic flexure of the colon, and superior to the upper pole of the left kidney. Calcified aneurysm of the renal artery simulates that of the splenic artery more closely than any other lesion. Pyelograms will disclose a pressure-filling defect in the renal pelvis or near the hilum (Key and Akerlund, 13, and Renck, 19). Echinococcus cyst, with calcification in its walls, located in the mesentery, left lobe of the liver, or in the spleen may have the appearance of a calcified aneurysm of the splenic artery. The cysts are usually multiple in the abdomen or other cysts may be located elsewhere in the body, principally in the lungs. Other lesions that appear as a calcified mass on the roentgenogram which require differentiation from aneurysm of the splenic artery include calcified cyst of the spleen (Andrews, 2), calcification in the cortex of a tuberculous kidney, perisplenitis ("zuckerzug spleen"), calcified mesenteric tuberculous lymph nodes, calcification in the walls of the renal cysts, calcified blood clot, enteroliths, and calcification in neoplasms.

PATHOLOGY

The gross and microscopic pictures presented by aneurysms of the splenic artery do not differ in any respect from those presented by aneurysm elsewhere. Trauma, embolism, arteriosclerosis, infections, and congenital vascular dysplasia have been described as etiologic factors. Any portion of the artery may be involved. In the 40

cases collected by Baumgartner and Thomas, 33 involved the main trunk and seven involved the branches at the hilus of the spleen. The size varied from 1 to 9 cm. in diameter. Twenty-five of these were single and eight were multiple. As many as nine separate aneurysms have been reported in the course of the splenic artery. Calcification in the wall is not infrequently seen.

The microscopic features of one of the cases of aneurysm of the splenic artery found at Cleveland City Hospital during a routine postmortem examination (Autopsy No. 12,894) are described by Dr. H. S. Reichle as follows: The proximal portion of the artery shows a well developed media with considerable fibrosis. The media has disappeared in the aneurysmal sac and is replaced by dense connective tissue. Near the aneurysm the intima is somewhat thickened by fibrosis, a process so marked in the sac as to make the wall two or three times as thick as that of the artery. In this situation there is slight calcification in the depths of the intima. There is no vascularization of the media nor perivascular cellular infiltration in the adventitia. The external and internal elastica extend for a considerable distance into the aneurysm where they become reduplicated, fragmented, and then disappear. The aneurysm compresses neighboring portions of the pancreas.

TREATMENT

The treatment of aneurysm of the splenic artery is obviously surgical. The procedure followed in the reported cases varied from tamponade to extirpation of the sac and spleen. All of those treated by tamponade died. However, in the face of active hemorrhage, ligation of the vessel may be extremely difficult and tamponade may be required. Ligation of the main trunk as near the celiac axis as possible should be the first step in the surgical attack on this lesion. Application of a ligature distal to the sac offers additional security against future enlargement. Prox-

imity to the spleen and anatomic changes may render the application of the distal ligature inadvisable. Some operators have removed successfully the spleen and aneurysm. This procedure is perhaps not justifiable unless the patient is in excellent physical condition. Furthermore, there is no assurance that extirpation offers a better chance of cure, inasmuch as Parsons (18) reported the occurrence a new aneurysm in the stump of the artery after removal of the spleen and sac. Proximal ligature in continuity or with interruption of the artery is the simplest procedure and gives reasonable assurance of effecting a cure. Our result is illustrative of the effectiveness of this treatment. The spleen is thought to undergo aseptic atrophy. This occurrence may be questioned inasmuch as the collateral circulation provided by the short gastric arteries may be sufficient to sustain the spleen. At any rate, there is no reason to believe that any harm results from not removing the spleen. It is reasonable to believe, because of the scantiness of the collateral circulation, that sufficient clotting takes place in the sac to produce a cure. A heavy, non-absorbable ligature was used in our case in the hope that this would prevent proximal recanalization.

Ligation proximal to and the injection of a sclerosing agent into the sac has been suggested and may prove to be a useful procedure.

SUMMARY

1. Aneurysm of the splenic artery is a rare disease which may have important clinical significance.

2. Only a few cases have been diagnosed before operation or autopsy.

3. Two cases with roentgen findings are reported in detail. One was operated upon by proximal ligation of the splenic artery with cure. The other case was asymptomatic and discovered by routine roentgen examination of the spine.

4. In over 58,000 autopsies partially collected from the literature, the percentage of aneurysm of the splenic artery

is 0.05. The percentage of aneurysms in general is 1.26.

5. The disease may or may not be accompanied by symptoms. If present, they may vary from mild to severe epigastric pain, more often in the left hypochondrium. When rupture occurs, the diagnosis must be differentiated from other acute abdominal conditions. The presence of a palpable, pulsating tumor with a systolic bruit is helpful in establishing the diagnosis.

6. Calcification in the walls of the aneurysm make possible roentgen recognition of the lesion. A ring-like shadow of calcium density, with less dense mottling in the center, is a characteristic finding on the plain roentgenogram. Aneurysm of the left renal artery and other calcified lesions in the left hypochondrium may be excluded by the use of contrast urograms and gastro-intestinal studies.

7. Pathologically, the lesion is similar to aneurysms of other peripheral arteries. Arteriosclerosis is the most frequent cause.

8. Surgical operation is the only satisfactory treatment. Ligation proximal, or both proximal and distal, to the aneurysm is the most conservative and usually effective method. Removal of aneurysm and spleen has produced cures in several cases.

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DISCUSSION

SAMUEL BROWN, M.D. (Cincinnati, Ohio): I am very glad to have listened to these case reports which help me to confirm a suspicion of a splenic aneurysm I entertained in one of my cases.

About two years ago I had a patient in whom an abdominal examination revealed a large circular calcified mass in the region of the spleen. She also had a very large heart occupying a great deal of the chest.

I am wondering whether or not Dr. Hauser's cases also had any cardiac lesions.

WALTER W. ROBINSON, M.D. (Memphis, Tenn.): I would like to ask one question. I would like to know the blood picture following the operation in which the splenic artery was ligated.

HARRY HAUSER, M.D. (closing): In answer to Dr. Brown's question, there was no cardiac lesion in either one of these two patients, as far as I know. The second patient had, of course, a marked degree of arteriosclerosis. It may be possible that he had some type of arteriosclerotic involvement in his heart, although he had no clinical evidence of coronary sclerosis.

In answer to Dr. Robinson's question, we believe that an aseptic atrophy of the spleen occurs after ligation of the splenic artery, although we have no definite evidence ourselves that atrophy occurs. Our knowledge on this point is based on what we have read in the literature, and we believe the explanation is reasonable in view of the fact that there may be a considerable amount of collateral circulation around the spleen.

As far as I know, there were no blood studies made after the operation. We have followed the patient for two years and she is in such fine condition that we did not even consider removing the gall bladder later. She is completely symptom-free and, from clinical evidence, is apparently normal.

THE SYSTEMIC CARE OF PATIENTS UNDERGOING RADIATION THERAPY¹

By JOHN DAY PEEKE, M.D., *Mobile, Alabama*

RADIATION therapy does not consist only in a skillful application to our patients, but the care given them before, during, and after treatment is a vital problem. In order to appreciate better its importance and with a desire to know what others were doing in this regard, I sent out a questionnaire to a certain number of well known radiologists for their personal opinion and experience in caring for their patients who were receiving radiation therapy.

I am presenting to you their experience along with mine, and also the experiences of others obtained from the current radiologic literature.

The diagnosis of the cases will not be discussed, neither will the technic; only the patients with cancer will be considered.

This discussion will be divided into four parts or topics: (1) the mental state; (2) radiation sickness and its treatment; (3) care of specific organs, and (4) pain.

MENTAL STATE

When one sees the patient for the first time it is often hard to know just what to tell him. More than half of the questionnaires sent out were answered by saying, "Tell the patient the truth." However, this answer was modified by saying, "Tell only the cases that have a chance at cure." "Always tell one or more members of the family the true diagnosis, outline the course of therapy, and warn them of the reactions, both systemic and local, also the prognosis."

"In a very few cases the patient can be told the whole truth." "Each case will have to be a separate problem. The person without a family will have to be told the true facts. A man with business ob-

ligations will have to be told more than the one who does not have business affairs to complete."

The mental phase of this subject has been well covered by Downs, Wammock, and Artman (1). They have stressed two points which are often overlooked: (1) tell the patient and family that there is no stigma attached to cancer, and (2) that it is not contagious. Dr. Downs and his associates also stressed another important point, namely, the immediate reaction of the family, expressed by the bringing of presents to show their sympathy, followed later by their accustomedness to the illness and the relaxing of the signs of the active interest which was at first shown. We should warn the family that most cancers are chronic in nature and that the patient should not be allowed to feel that he has become a burden. The family and physician should always be cheerful in their contact with the patient, a state of mind which demands more effort of will on the part of the physician because most doctors do not like to follow hopeless cases.

Two articles have appeared in RADIOLoGY concerning what cancer patients should be told. Riebel (2), the writer of one, said: "Tell the curable cases. Honesty is a practical policy." Meland (3), the author of the second paper, said: "Tell the truth if you expect to control cancer, just as you do in cases of tuberculosis, diabetes, nephritis, and in cardiac cases."

My feeling is that most patients should be told enough to acquaint them with the knowledge that their condition is serious and that co-operation is necessary for results. Try not to alarm them and, as the course of treatment progresses, more can be told with less mental distress. Patients who have known that they had a cancer and have been cured, can be of more encouragement to other cancer patients than all the doctors.

¹Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11-15, 1939.

I do not think we should lie to a patient unless he is far advanced and perhaps not quite alert mentally. One of our Negro friends made this quite clear: "If I tell the truth, I can go off and leave it, but if I tell a lie, I have to stay and watch it."

RADIATION SICKNESS

The early symptoms of radiation sickness are anorexia, gas, malaise, increased fatigability, and nausea. These may occur within a few hours after treatment or not until several days have elapsed. Some of these symptoms are to be found to some extent in most cases. The more severe symptoms, which usually occur after several days or even weeks, are vomiting, nervousness, depression, and increased weakness. These do not occur save in a small percentage of cases. In a very small group of cases we see even more severe reaction, such as toxemia, fever, severe weakness, usually with anemia and possibly leukopenia. We have seen two cases with allergic reactions. In one, a giant urticaria was seen, while the other showed a maculopapular rash over the whole body, accompanied by severe itching.

The causes and explanations of radiation sickness are numerous. Martin and Mour-sund (4) presented a review, and their ideas on this subject at the Fifth International Congress of Radiology. Recently, Graham (5) has again reviewed the subject and added his findings. Holmes and Hunter (6) divided radiation sickness into three types: (1) toxic sickness resulting from the destruction of large masses of tumor tissue; (2) psychic sickness due to the patient's associating the idea of the radiologic department to real sickness; (3) true radiation sickness, which is the symptom-complex resulting from the effects of x-rays or radium on the body. Most cases of radiation sickness that need therapy fall into the group of true radiation sickness. The cause of this last type has been explained as due to some of the following conditions: (1) toxicity, due to tissue

destruction; (2) inhalation of nitrous and ozone gas in the treatment room; (3) static electricity in the body; (4) changes in sodium, calcium, potassium, and chlorine metabolism; (5) acidosis due to cellular disintegration; (6) injury to intestinal mucosa due to nitrogenous products in the blood; (7) liver damage; (8) changes in vegetative nervous system; (9) changes in blood cholesterol; (10) endocrine imbalance; (11) allergic phenomena; (12) production of roentgen toxin; (13) enzyme stimulation.

With the numerous explanations for radiation sickness, there have been equally as many types of treatment. Masks have been used mainly by Friedman and Drinker (7), with good results in approximately 92 per cent of the cases. Glucose and saline solutions have been given intravenously in severe cases; alkalies, laxatives, fluids, and fruit juices all have their place. Young (8) used liver extract with good results. Richards and Peters (9) have had good success with nembutal. Martin and Mour-sund (4) have found that vitamin B₁ is most effective in both prevention and treatment of radiation sickness. It does not have the depressing effect of the sedatives which relieve for only short periods. Graham (5) has found that nicotinic acid is helpful in treating radiation sickness. There are more cases of sickness among patients who have been treated over the abdomen, especially the upper abdomen. Therapy over the parotid gland often causes severe symptoms.

Some therapists say there should be no radiation sickness, and that by giving small doses through a small port, the sickness is prevented. Others claim that with the use of supervoltage machines far less radiation sickness results.

The writer tries to adopt a combination of the different types of therapy. The patient should be helped to maintain the best state of mind. Encourage some outdoor exercise or occupation. Take whatever measures are necessary to assure free elimination of the bowels and kidneys. Prescribe a diet containing plenty of fruits and

liquids as well as easily digested carbohydrates. Have the patient get plenty of rest, even if a sedative has to be prescribed. I usually put the patient on some vitamin B preparation. The doses of x-ray that I give are small, at first, and generally I do not use a port of more than 100 sq. cm. The dose is increased as the patient becomes able to tolerate it. If there is vomiting, some barbiturate is used, either by mouth or rectum. Occasionally glucose and saline are given intravenously and, if the sickness is prolonged, I stop therapy for several days. The blood picture should be watched to prevent a severe anemia or leukopenia and the urine and blood chemistry should be noted. A complete physical survey is indicated to be sure that there are no other conditions to account for the sickness.

CARE OF SPECIFIC ORGANS

The skin is perhaps the most important organ in the causation of discomfort while treating some of the deeper tissues. We are all aware of the different degrees of skin reaction, from the first degree with a slight reaction, to the severe fourth degree with deep vesiculation and necrosis such as usually do not heal. The chief danger to be guarded against is a skin reaction which will not heal. Such reactions are usually the result of mistakes or treatment by one who does not fully understand the effects of x-rays.

In this paper we are concerned with the first three degrees of skin reaction, especially, the first and second. These are moderate erythema, with hyperemia and pigmentation. Occasionally we go on to a true vesicular reaction, but here we should be cautious. The care of the simple skin reaction consists in merely keeping the skin clean and dry, using sterile powder, calamine lotion, or Dodd's solution. If there is vesicular reaction, with pain, the use of one of the local anesthetics, such as nupercainal ointment, butyn picrate ointment, zinc oxide, or other soothing organic oils is indicated. The skin should be kept clean with sterile

solutions of saline, Dakin's solution, or boric acid, magnesium sulphate, or aluminum acetate (4 per cent). Halibut oil and cod liver oil have been used. Aquaphor has been used by Kaplan (10), at Bellevue Hospital, with good results. *Aloe vera* fresh leaf or the fresh ointment has been used and found to be the most successful drug in the healing of the more destructive skin reactions. Collins (11) has reported good results, also Brown (12) and Mandeville (13).

In the cases in which there is fourth degree reaction or x-ray burn, it is better to use electrosurgery and plastic surgery. Blair, of St. Louis, has done much for these cases.

When the radiation has been directed through the head, face, or neck, there are special treatments to be followed. We should relieve high increase in intracranial pressure by lumbar puncture, and decrease, or stop, therapy until this subsides. Some therapists like to have a decompression done before radiating brain tumors.

In the case of therapy to the eyes, one should tell the patient of the possible damage even if the best screening is done. Keep down infection by simple mild antiseptic solutions, saline solution, and boric acid. Some of the silver preparations, such as argyrol (5 per cent), are useful after radiation therapy is completed. If the eye is very painful and the vision is gone, it is best to have it removed.

The care of the nose, mouth, and throat is important, especially the care before radiation. As nearly as possible, the fields should be free of infection, and for this purpose douches, mouth washes, and sprays are useful. The teeth should, in most cases, be extracted, for they usually will have to be sacrificed later if large doses are given. Wax, chewing gum, or sweet candy will help relieve the dryness in the mouth following radiation over the salivary gland. If large doses are to be given to the neck, it may be better to do a tracheotomy, although we usually wait until it is necessary and, in a large majority

of cases, find we can save the patient that extra discomfort. Martin (20, 21), of Memorial Hospital, is a leader in radiation of such cases.

The care of the thorax, other than the prevention of pneumonitis, is not very difficult.

The care of the digestive tract should include the large problem of diet. Usually a high caloric, easily digested diet is indicated. In fact, this is such an important element in the care of the cancer patient that it can best be handled by a capable dietician. Usually tonics, such as vitamins, liver extracts, wine, whiskey, etc., are useful.

Proper elimination from the intestinal tract should be stressed. We usually employ mineral oil and a mild laxative, if necessary. The mineral oil will cut down on absorption of toxins and prevent some damage to the intestinal mucosa. The care of the rectum is usually quite a troublesome problem. The diarrhea which so often follows radiation of the lower abdomen and pelvis is best controlled by bismuth and paregoric. Kaolin and similar drugs are useful. A non-residue diet is most important. Rectal irrigations should be followed by oil instillations. Suppositories containing local anesthetics often will give a patient comfort. In this connection, Bacon (19) has discussed proctitis in a recent article. Sitz baths, enemas, etc., will often give help, though rest in bed is perhaps the one most beneficial method. The genito-urinary tract needs little attention other than the maintenance of good elimination from the kidneys. The care of the bladder, in case there is local or adjacent pathology, is usually confined to irrigations and drugs to relieve the discomfort, such as tincture of *Hyoscyamus* and alkalies.

In pelvic and vaginal cases, we have found that first relieving the infection is most important, to be done by the use of antiseptic douches, tampons, and Sitz baths. Some have found sulphuramide preparations highly satisfactory. Following radiation, the care consists of simple irrigation and mild local anesthetics.

Bone involvement is usually a matter of fixation to prevent further pain by a pathologic fracture; if an open wound, it should be cared for in the usual manner. Radiation will often relieve pain from bone metastasis.

Blood counts should be checked frequently. The most common variation is leukopenia, especially in the form of lymphopenia, and anemia is sometimes present, according to Richman (18). If leukopenia is found, stop therapy and build up the blood. Often the anemia will improve while the therapy is in progress, due to stoppage of bleeding. If the anemia is profound, the patient should have a transfusion. Liver, iron, and copper preparations should be administered and if the hemoglobin is below 40, therapy should be discontinued.

PAIN

The most dreaded phase of any disease is pain and the least we can do is to make a patient comfortable. In many cases that is all we can possibly hope to accomplish.

Pain is usually due to local extension with possible infection, pressure from surrounding tissue, fibrosis from healing or secondary to radiation, and, later, pain due to the absorption of toxins. The pain from extension and infection can often be relieved by surgical removal or drainage, and proper cleansing of the wound. Pain from surrounding tissue can be helped by surgical intervention, in some cases. The discomfort from fibrosis and scars is often quite painful but with proper surgical procedure may be relieved. Pain from absorption and toxemia is best controlled by proper elimination and drainage of pus; sulphuramide in selected cases is also helpful. Surgical manipulations, such as the following, are most useful and will give considerable relief: thoracentesis in cases of large pleural fluid collections will make the patient more comfortable; paracentesis will relieve considerable abdominal discomfort if there is a large collection of fluid. Removal of obstruction, such as

gastric, colonic, vesicular, or tracheal, by gastrostomy, colostomy, cystotomy, or tracheotomy gives great relief to the patient. Fixation of the bone in cases of metastasis also eases the patient.

The neurosurgical procedures are often quite helpful but in many cases are disappointing. Fay (14, 15) and Grant (16, 17) have done much to develop this phase of therapy. The injection of alcohol is quite old but in proper hands may give good results, especially in the subarachnoid space. Chordotomy and pelvic sympathectomy have been found useful. In answer to their questionnaires, most of the men stated that neurosurgical procedures had been disappointing but were worth while trying in some cases.

The drugs most often used for relief of pain are aspirin or some of those in the coal tar group, alone or with other combinations, barbiturates either alone or in conjunction with other drugs, either coal tar derivatives or opiates. The use of opiates should be saved until other drugs fail. Common drugs used are: aspirin, codeine, barbiturates, morphine, pantopon, dilaudid, and scopolamine. Cobra venom has been used with some good results and although it does not depress the patient, it is quite expensive. Calcium in large doses has offered some relief of pain. Local lesions can be made more comfortable with soothing dressings, and local anesthetics are most welcome in extensive local lesions. *Aloe vera* leaf has also been reported to be useful in extensive local lesions. Mandeville (13) used it in the mouth with considerable satisfaction. Tampons, douches, enemas, irrigations, and suppositories, with mild local anesthetics, are sometimes comforting.

Physical methods such as heat, cold, or radiation are often useful. X-ray therapy will give considerable relief in cases of painful bone lesions as well as numerous other lesions. In small doses it will help to relieve the infection and decrease the pressure by relieving the tumor mass. Radiation of the ovaries in cases of bone metastasis from cancer of the breast will

usually give marked relief if the patient has not passed the menopause. Pack and his co-workers (22) used palliative radiation for gastric cancer with favorable results in a few cases, nevertheless, it certainly should not take the place of surgery. One could give examples of special conditions throughout the entire body in which radiation is most useful in relieving pain.

Warren (23) showed that artificial fever was useful in treating the hopeless cases and suggested that it be studied further. Smith and Fay (24) presented an interesting paper and exhibit at the St. Louis meeting of the A.M.A. on reducing the body temperature to 89° and refrigerating locally. Patients were kept in a state of hibernation for five days, and, when the temperature was allowed to return to normal and the patients to regain their original consciousness, considerable relief of pain lasting for long intervals of time was noted.

Other physical methods, such as local heat or cold, hydrotherapy, etc., are useful in treating such cases.

SUMMARY

I have tried at least to mention and outline the management of some of the most common problems that we, as physicians, have to face in taking care of patients undergoing radiation therapy. These are discussed under four headings: (1) mental state; (2) radiation sickness; (3) care of specific organs, and (4) pain.

There is little new in this paper but I hope it will help in assembling these facts.

I am greatly indebted to Leon J. Menville, M.D., for numerous suggestions in preparing this paper.

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DISCUSSION

OSCAR R. TROJE, M.D. (Fairfield, Ala.): After passing several days in this morass of technology, and an almost endless ob-

servation of the rare and unusual, it is a pleasant change to get back to the consideration of the practical problems of applied radiology.

Of the four subdivisions of Dr. Peake's paper, I will only consider the first and probably the most neglected one, "The Mental Attitude."

I would like to compliment Dr. Peake on calling our attention to the fact that the radiologist is primarily a physician confronted in his everyday work with a physician's problems. These problems can probably be more efficiently solved by a well organized and, what is more essential, a highly co-operative group than by any isolated individual.

At least one of the group, preferably all of them, should have enough patience and understanding of human nature to talk to the patient and his family in terms suited to their mental and social level. In other words, someone must be able to adjust himself to the lowliest laborer working in the fields or mines, while talking and explaining things to him, especially explaining the reaction that is going to occur. Or, he may have to talk to the president of a corporation and do the same thing. One has to be able to do this in order really to get the patient's co-operation.

The best place to acquire the necessary patience and understanding of human nature, in my opinion, is in private general practice, preferably removed from large medical centers. It has been my experience that patients resent, more than anything else, being patronized, and I think they are beginning to be patronized a great deal from the reports that come to me, and I see many patients. I have had patients complain to me about other physicians in such expressions as, "He is too uppity," and "He thinks he is so high and mighty." Obviously it is impossible to get co-operation from anyone who harbors a smouldering resentment of this kind.

I think a little more time devoted to a study of the psyche of the patient would pay well.

JOHN T. MURPHY, M.D. (Toledo, Ohio): I think this is an extremely important subject and I agree with Dr. Stone that at one of these meetings, someone should give a whole day or half a day to the subject that has been under discussion here.

I have a few ideas on this sort of thing. You hear a lot of the treatment of skin. I think men who are familiar with the work we are doing agree that we probably get as much skin effect from high dosage as anybody in the country because we simplify our technic and use large doses over single fields in whatever cases possible.

We do not treat the skin at all. We just give the patient a box of talcum powder or have him get it, and every time he starts fussing about the skin, he has orders to put more talcum powder on. We eliminate all water and washes. That may not be the way you want to treat them, but we have little difficulty in healing these massive reactions. I am speaking of reactions in which the dosage is upward from 7,000 or 7,500 or with 400 kv. therapy over one skin area given in 40 or 42 days.

The average idea of radiation sickness in many men's minds is a nausea and a vomiting. What I consider radiation sickness is the condition that comes on during protracted series of radiation. We have been quite successful in combating this condition by the use of concentrated liver extract in doses of from 1 to 2 c.c. every day. It is given to the patient in the office, either before or after he receives treatment.

That does not control everything, but occasionally you see a patient, say, 65 or 70 years old, with carcinoma of the larynx or tonsil, apparently on his last legs, snap out of it with liver extract.

Dr. Peake has mentioned putting the patient to bed and stopping the treatment. I do not find that necessary. After all, you are treating cancer and if you are going to treat cancer with the hope of cure, radiation therapy must be given with a certain form to produce certain results. If you want to cure the patient, and you

think you can cure the patient, too much deviation from this technic is not going to produce the results.

By carefully telling the patient, or the family, what to expect, and then insisting that they do it, with proper supportive measures, we rarely have to discontinue treatment, even in the bad cases.

ROBERT S. STONE, M.D. (San Francisco): There are a few points I would like to have the privilege of discussing, and one was the statement about the use of calamine. Calamine is largely a zinc preparation, and we have felt that the use of any zinc preparation, whether zinc stearate or calamine lotion, added such a factor of secondary radiation to the skin that they should not be used. Of course, they can be used after the course of treatments is over.

A similar objection applies to the use of bismuth for bowel irritation when treating the lower abdomen. When you put bismuth in the bowel, you increase the irritation of the bowel by soft secondary radiations from it and you may even obstruct large amounts of irradiation from going beyond the bismuth.

A third point, from his questionnaire can the essayist tell us how many doctors demand that some decompression be done on brains before x-ray treatments are started for intracranial tumors? We have treated a large number of brain cases, and I fail to find that any of them have the increased pressure after treatment which has been said to be such an important factor to watch for and to avoid by small doses.

Another thing, I would like to lay the bugaboo that seems to persist still about extra high voltage radiation not giving radiation sickness. So-called supervoltage radiation, if you give it in equivalent biologic doses, gives just as much radiation sickness as the same amount of radiation applied to the same amount of tissue obtained from other voltages.

DR. PEAKE (*closing*): I am afraid I

might have misled you a little in regard to the use of grease on the skin. The only time we use grease is after there is a severe epidermitis. This is usually after radiation is completed. The same thing applies with calamine lotion and similar drugs.

These, again, are used only after treatment is completed.

In regard to decompression, I am guided entirely by the advice of the neurosurgeons. After all, the neurosurgeon is in charge of the patient.

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INDUCTION BY ROENTGEN RAYS OF HEREDITARY CHANGES IN MICE¹

By GEORGE D. SNELL, Sc.D., *Bar Harbor, Maine*

From the Roseoe B. Jackson Memorial Laboratory

THE high potency of roentgen rays as an agent for the production of hereditary changes was first established by J. H. Muller, in 1927. Since Muller's initial discovery, made with the fruit fly, *Drosophila melanogaster*, other investigators have obtained similar results using a variety of plants and animals. It is now established beyond question that the germ cells of a large variety of living things when exposed to x-rays transmit hereditary changes to succeeding generations.

The experiments here described were performed with the mouse, a mammal, and hence are a considerable step toward showing the applicability to man of results first obtained with plants and the lower animals. Mice, because of the large numbers that can be raised in a short time, are the ideal mammals for studies of heredity.

In the first experiment, male mice were x-rayed and mated to normal, non-irradiated females. Dosages used ranged from 200 to 1,600 r. Most males were treated with 600 or 800 r as these doses proved most suitable for the study of induced germinal variations. Following such treatment there is an initial fertile period which lasts about two weeks. Thereafter for a period of some weeks the males are sterile and during the latter part of this period spermatozoa are absent from the sperm ducts. About three months after x-raying, spermatozoa reappear in the vas deferens and the animals again show normal fertility.

While males will produce litters for about two weeks after irradiation before becoming sterile, litters sired during this period are reduced in size. Figure 1 shows how this reduction in litter size is related to dosage. It will be seen that treatments

of 600 and 800 r, the ones chiefly used in these experiments, reduced litter size to an average of about three young per litter, somewhat less than one-half the normal.

This reduction in litter size is evidence that irradiation produces hereditary changes in mature sperm. However, since much more conclusive evidence was obtained from the second and later generation descendants of the x-rayed males, this particular phenomenon will not be discussed further.

The offspring of irradiated males by normal untreated females were raised and, in turn, mated to normal untreated mice. The immediate offspring of the irradiated males will hereafter be referred to as F_1 mice, the second generation offspring as F_2 mice. It was found that some of the F_1 mice in the experimental group consistently produced small litters (Fig. 2). It will be seen that in the control group no litters of less than five young were produced. In the x-rayed group, on the other hand, there were numerous litters of four young each, and some of three, two, and even one young. These small litters were produced by only certain animals; about two-thirds of the F_1 mice produced only normal litters, about one-third consistently produced small litters, a few were completely sterile.

The tendency of certain mice in irradiated stocks to produce small litters has been named "semi-sterility." Tests show that it is transmitted to later generations. Concerning this point I shall have more to say, but, first of all, it is appropriate to consider the nature of the change in the hereditary mechanism which causes it.

To understand the genetic basis of semi-sterility, it is necessary to consider the two types of hereditary changes which x-rays are known to produce. The first of these is gene mutations, that is, changes

¹ Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11-15, 1939.

in the individual, submicroscopic hereditary unit or gene. Such gene changes give the familiar 3 to 1 mendelian ratios. They affect a great variety of characters in the mature organism; in the fruit fly, for example, eye color, wing length, or sometimes such essential developmental processes that they are lethal in their effect. Most important of all for what follows, with a few special exceptions, they produce aberrant individuals only following inbreeding.

With one possible exception I have found no evidence that this type of hereditary change is produced in mice by x-rays. This is not to say, however, that if even larger numbers were raised some few at least would not be found.

The second type of hereditary change produced by x-rays is the type known as the chromosome mutation, that is to say, the loss of whole segments of chromosomes with all the genes that these segments carry, or the transfer of such segments to other chromosomes. It is now established that the commonest genetic effect of x-rays is the production of chromosome mutations. There are several classes of chromosome mutations. We shall consider only one particular class, the translocation.

The nature of a translocation is indicated by Figure 3. It consists of the breaking-off of a piece of one chromosome and its at-

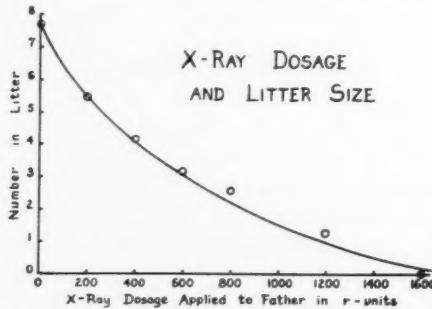


Fig. 1. Graph showing the relation between the x-ray dosage applied to males and the sizes of the litters which they sire. These litters were all sired within two weeks of the x-ray treatment. Following this initial fertile period of about two weeks' duration, there is a sterile period which usually lasts from one to several months. This, in turn, is followed by a return of completely normal fertility.

attachment to another chromosome. The translocation may be reciprocal, that is, the chromosome receiving the broken end may yield up an end in return, so that there is an exchange of terminal segments. The translocation figured is of this type. It should be emphasized that the two chromosomes involved are members of different pairs, not members of the same pair. A fruit fly, a mouse, or any other plant or animal carrying a translocation appears to be perfectly normal. All the hereditary units or genes are present and unaltered in their individual structure, the only difference being in their arrangement.

While an individual carrying a translocation appears to be perfectly normal, its breeding behavior is altered. This is shown on the second line of Figure 3. Such an individual mated to a normal unrelated individual produces six classes of offspring, only two of which, in animals at least, are viable. These two viable classes are like the two parents, one a carrier of the translocation, the other entirely normal. They are produced with equal frequency and together constitute at least half the total number of offspring. The remaining four classes each have failed to receive some chromosome segment normally present. Experiments have dem-

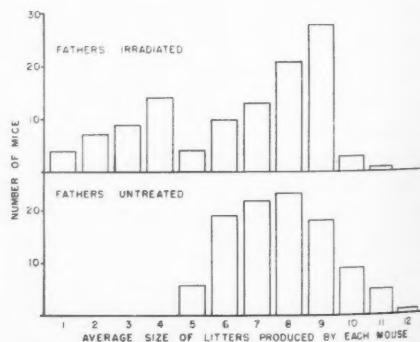


Fig. 2. Graph showing the distribution of 103 control mice and 114 mice from x-rayed fathers, grouped according to the average size of the litters which each produced. Note that many of the mice sired by x-rayed fathers, although to all superficial appearances normal, consistently produced small litters. These mice carried translocations, that is to say, alterations in the structure of the chromosomes, which had been induced by the irradiation.

onstrated that in the fruit fly, *Drosophila*, this lack of a chromosome segment is usually lethal. Flies thus constituted do not develop to maturity.

We may thus predict that mice carrying a translocation, when mated to normal mice, will produce two equally numerous classes of living offspring, (1) carriers of the translocation and (2) entirely normal mice. In addition, they will produce some embryos which, because of the lack of a chromosome segment or block of genes, will fail to survive. Let us see how the actual observations accord with these predictions.

A number of semi-sterile offspring of irradiated fathers were outcrossed to normal mice, and their offspring, in turn, mated to normal mice to see whether or not they had inherited the semi-sterility. The results of such a test are shown in Table I, in which are listed 27 descendants of semi-sterile F_1 male number 146. From two to ten litters were raised from each of these 27 mice, and the mean size of the litters produced by each mouse is given. It will be seen that the mice fall into two approximately equal groups, the first composed of mice which consistently produced small litters, the second composed of mice

which consistently produced litters of normal size.

Semi-sterility is thus definitely transmitted, and, further, it is transmitted to about one-half the offspring of every semi-sterile mouse. This fact has been demonstrated by numerous tests. It should be emphasized that its appearance does not depend on inbreeding. In all these tests semi-sterile mice have been mated to unrelated normal mice from untreated stock.

Insofar, then, as the transmission of the trait is concerned, the observed behavior of semi-sterility is in accord with the predictions. It remains to consider the production of non-viable embryos. To test this, normal females were mated to semi-sterile males and killed about 12 days after mating. Their uteri contained three classes of embryos: (1) embryos already dead and beginning to degenerate; (2) living embryos with abnormal brains due to failure of the neural groove to close at the anterior end, (3) entirely normal embryos. Figures 5 and 6 show some of the embryos with brain abnormalities. Em-

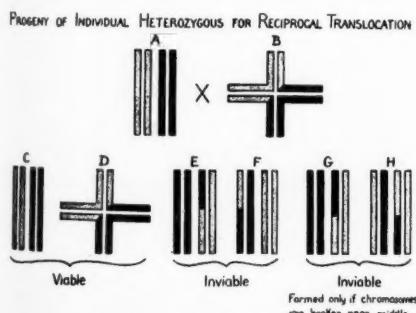


Fig. 3. Diagram showing the hereditary behavior of reciprocal translocations. *A*, two pairs of normal chromosomes in a normal mouse; *B*, the corresponding chromosomes in a mouse with a reciprocal translocation. Matings of *A* and *B* give rise to individuals of the types *C*, *D*, *E*, *F*, *G*, and *H*. *C* is entirely normal; *D* is normal in appearance but transmits the translocation; *E*, *F*, *G*, and *H* give rise to abnormal embryos. This figure should be compared with Figure 4. It shows the mechanism responsible for the type of transmission found in studies of induced hereditary changes in mice.

INDUCTION AND TRANSMISSION OF TRANSLOCATIONS IN MICE

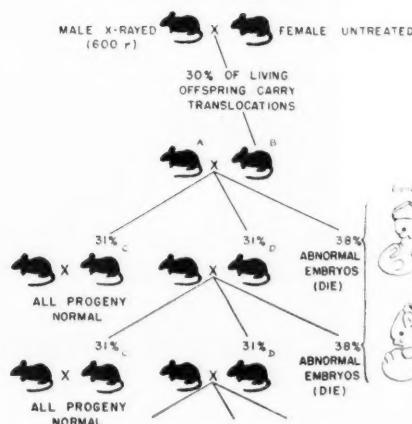


Fig. 4. Diagram showing the induction and transmission of translocations in mice by roentgen irradiation. (Based on data from Snell, Bodemann, and Hollander, *Jour. Exper. Zool.*, **67**, 1934, and Snell, *Jour. Genetics*, **20**, 1935). For the meaning of the letters *A*, *B*, *C*, *D*, *E*, and *F*, cf. Figure 3.

bryos of this type have been found in all the translocation stocks studied, a rather

tendency to live to term vary considerably from one stock to another. As a rule em-

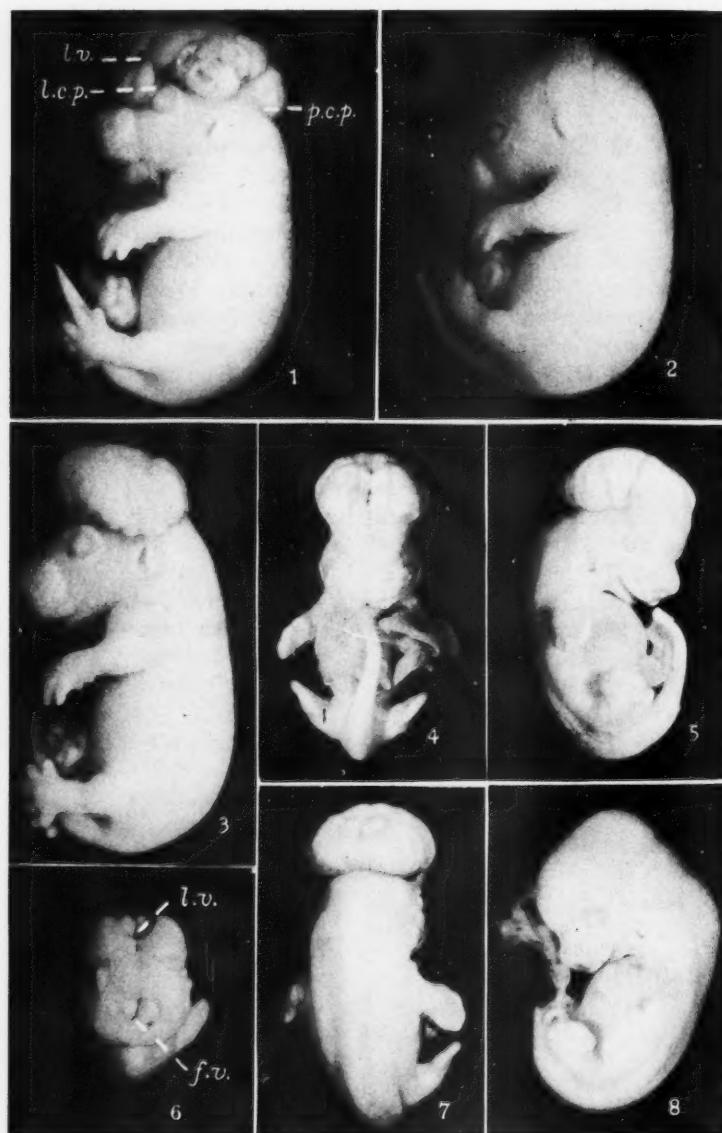


Fig. 5. Embryos from a translocation stock. Numbers 2 and 8 are normal embryos, the rest are abnormal embryos. (*Jour. Genetics*, 31.)

surprising fact since the different translocations presumably involve quite different chromosomes. However, the incidence, the extent of the abnormality, and the

bryos of this type seldom live to term and they are usually less numerous than the embryos which die in the early stages of development.

The results of x-raying male mice are summarized in Figure 4. When male mice though entirely normal in appearance, are found by breeding tests to be semi-sterile.

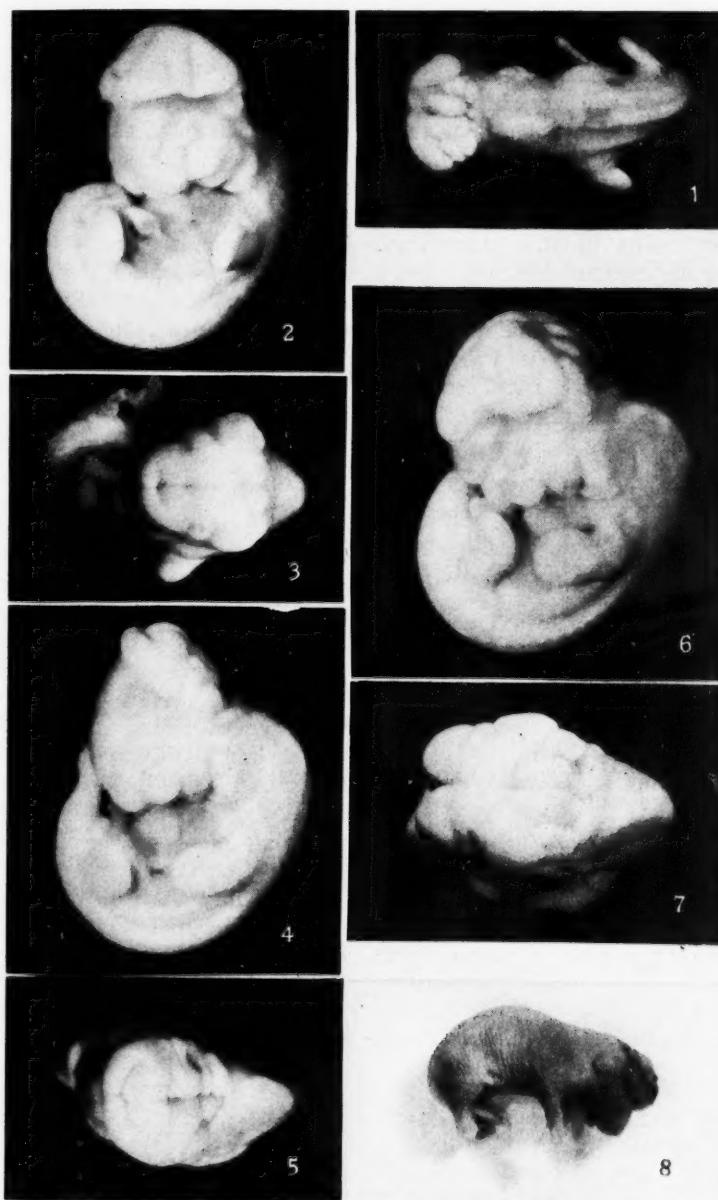


Fig. 6. Abnormal individuals from a translocation stock. Numbers 1 to 7, inclusive, are embryos of about twelve days embryo age. Number 8 is an abnormal animal at term. (*Jour. Genetics*, 31.)

are irradiated with from 600 to 800 r units, about one-third of the living offspring,

When mated to normal mice they consistently produce small litters due to the

death *in utero* of some of the embryos. Rarely, abnormal young come to term. Every semi-sterile mouse transmits the semi-sterility to about one-half his offspring.

Two points should be emphasized. First, abnormal embryos and abnormal young due to translocations do not appear until the second generation following irradiation. Consequently, clinical studies of the immediate offspring of x-rayed parents are without significance in this connection. Second, their appearance does not depend on inbreeding.

In addition to the experiment with irradiated males, an experiment was carried out in collaboration with Dr. Forrest B. Ames, in which female mice were irradiated. Preliminary tests showed that fe-

males irradiated with from 600 to 800 r were completely sterile, perhaps due to damage to the uterus or failure of normal corpora lutea to form. The dose finally selected was, therefore, only from 240 to 280 r. Of 151 offspring of females treated with this dose, three were typically semi-sterile. Three others apparently carried some form of altered heredity, for among numerous descendants of each of the three there was a single abnormal individual. The abnormalities were similar to those found in translocation stocks but in two of the three cases less in degree, consisting in one case of a small hernia of brain tissue through a hole in the top of the cranium, and in the other case simply of a small papilla on top of the head with a slight abnormality of the bones underneath. This last animal lived to maturity but was sterile. The genetic basis of these cases is uncertain. In addition to the above, three offspring of the irradiated females were completely sterile, histologic observation revealing abnormal gonads. One of them, a male, lacked testes altogether, though other male structures were present. Thus in all, 9 out of 151 F_1 mice, or 6 per cent, were genetically abnormal. Seventy-one tested animals from control mothers were all normal. The incidence of abnormality in this experiment is less than that found following irradiation of the male, but the dose also was less.

In a third experiment in which male mice were irradiated with neutrons instead of x-rays, similar results were again found. Of the F_1 offspring, 12 per cent were either semi-sterile or completely sterile. The semi-sterility was inherited.

DISCUSSION

R. R. NEWELL, M.D. (San Francisco): It is a great privilege to listen to the report of one of the few men who have been working on x-ray injuries to the genetic apparatus in mammals.

Many years ago, when Muller first demonstrated direct induction of heritable changes in fruit flies, I got very much worked up about this because it seemed to

TABLE I.—PROGENY OF MATING SEMI-STERILE \times NORMAL

Colony No.	No. Litters	Mean Litter Size	No. Young with Cranial Hernia
<i>A. Semi-sterile Progeny</i>			
♀ F ₂ 31	2	3.5	0
♀ F ₂ 776	5	3.6	0
♀ F ₂ 723	3	3.7	0
♂ F ₂ 559	9	4.1	0
♂ F ₂ 17	6	4.5	0
♀ F ₂ 770	6	4.5	0
♂ F ₂ 560	8	4.7	0
♂ F ₂ 535	7	4.7	6
♂ F ₂ 725	7	4.9	2
♀ F ₂ 23	3	5.0	0
♂ F ₂ 16	10	5.1	1
♂ F ₂ 771	5	5.2	0
♂ F ₂ 778	7	5.3	0
Total	78	4.63	9
<i>B. Normal Progeny</i>			
♂ F ₂ 25	2	6.5	0
♂ F ₂ 27	5	7.4	0
♂ F ₂ 26	2	7.5	0
♀ F ₂ 774	4	7.7	0
♂ F ₂ 24	6	7.8	0
♂ F ₂ 772	10	8.2	0
♂ F ₂ 32	3	8.3	0
♀ F ₂ 533	2	8.5	0
♂ F ₂ 562	8	8.5	0
♀ F ₂ 423	3	8.7	0
♂ F ₂ 561	7	8.7	0
♂ F ₂ 779	5	9.0	0
♀ F ₂ 777	3	10.3	0
♂ F ₂ 726	2	10.5	0
Total	62	8.37	0

have some importance in the problem of protection from stray radiation.

It has been proven by a number of workers that many of these genetic injuries have no recovery rate. That is to say, it does not make any difference how long you have taken to give a dosage, no matter how small a momentary intensity, no matter if it took ten years to put in a given dosage of radiation, the total result in genetic injuries would be just the same as though it had been given rapidly. It seems to me that this is highly important in the problem of protection.

Muller's work on fruit flies has shown some types of chromosomal injury in which, apparently, one particular gene has just been knocked out, and so produced hereditary change by the loss of that particular genetic material. But, it is known that in insects, most of the genetic changes are due to chromosomal translocations, fragmentations passed down to subsequent generations.

That is the sort of thing which we have heard about in this paper on mammals. Dr. Snell assures me that he has no evidence in his mice of direct chromosomal injuries in which just one gene has been knocked out. However, the number of individuals and the number of generations which can be investigated in fruit flies is enormously higher than the same amount of work makes possible in mammals, so that there still may be such a thing happening in mammals.

If there is no other source of heritable injuries produced in mammals except the one Dr. Snell has shown us to-day, one would feel much better about it, because an injury to the future of the human race which consisted of only a semi-sterility would not be so intolerable. But, if we find in the future there are other sorts of chromosomal injuries, partial changes—not lethal, but only injuries—and let persons grow up to fill the future human race with individuals whose constitutions are in some degree abnormal, but not sufficiently abnormal to cause the death of the fetus, that would be a very terrible thing. I

do not think that even now we can overlook that possibility entirely.

My feeling, in listening to these men who have done their work with animal material, is that we ought at least to apply the possibility to ourselves and say that even small doses of radiation administered to persons who may in the future have children are to be looked upon with extremely grave apprehension.

PAUL S. HENSHAW, Ph.D. (Bethesda, Md.): I attended a meeting in New York City last Spring which was devoted to this same subject. The group in attendance was composed mainly of clinicians and biologists and the question of whether or not germ-cell injury produced by radiation may affect offspring was discussed at length.

The biologists present set forth considerable evidence obtained with lower forms, which is in agreement with the findings of Dr. Snell. In contrast to this, however, the clinical contingent was unable to cite a single instance of abnormalities in human offspring resulting from the irradiated germ cells of parents.

Why is it, then, that abnormalities have not been observed in humans? Is it that mutant changes have not, as Dr. Snell suggests, had sufficient time to become manifest? Has there been a reluctance to report such cases? Has it been impossible to know whether or not irradiation germ-cell injury may be the cause of abnormalities that do occur? Or is there some other reason?

It appears that most of the injuries observed in the lower forms were obtained by irradiating mature germ cells. I should like to ask Dr. Snell if he has any information as to whether or not immature germ cells sustaining irradiation injury are in some way eliminated or prevented from coming to maturity and participating in fertilization.

JOHN T. MURPHY, M.D. (Toledo, Ohio): I am out of the field a little, but would it be possible that the second and third

generations of human beings, those sons and daughters of persons treated by early radiologists, are now available for a study of this type? Would it not be all right to make a survey of those persons and see what is happening?

DR. SNELL (closing): I think there are really two points which have been brought up.

The first is the question as to whether or not clinical studies of the children of x-rayed parents are adequate to prove or disprove the occurrence of induced hereditary abnormalities. Despite the large number of humans who have been exposed to x-rays, I doubt if the clinical records concerning their offspring are sufficiently extensive or thorough to furnish as good evidence as can be obtained from laboratory experiments with rodents. More important in regard to the significance of clinical data is the fact that abnormalities resulting from translocations do not appear until the second generation. The first generation offspring carry the translocation but do not show it in any way except by semi-sterility. The visibly abnormal offspring appear in the following generation; in other words, two generations after irradiation. So far as I know, clinical studies have not been carried out on the grandchildren of x-rayed individuals to see if abnormalities appear in that generation. The type of abnormality caused by translocations in second generation offspring can appear in the first generation, due to other types of chromosomal upset, but such cases are exceedingly rare. I have

found only one such case in mice, an embryo with the brain abnormality typically produced by translocations. As compared with this one case in the first generation, abnormal embryos and abnormal young at term in the second generation are numerous.

The question which Dr. Henshaw raised in regard to whether or not germ cells are injured if x-rayed before they are mature, was discussed in Germany a great deal. The contention was put forth that if the germ cells are treated in the early stages of their development, abnormalities do not appear in the descendants derived from them. I think there is probably a good deal in this contention. As far as my own results go, the translocations are found only in the offspring derived from sperm x-rayed when mature. If male mice are x-rayed, there is an initial fertile period, then a sterile period, then a return of fertility. If the offspring produced in the second fertile period are studied, there seems to be little evidence that they carry translocations. I have not studied such mice extensively, however, and would not want to speak too definitely.

There is good evidence that certain types of hereditary changes (gene mutations) can be produced in immature germ cells, but the chances are that the frequency of such induced abnormalities is low. In other words, applying this to humans, if a good interval elapses between treatment and the conception of children, there is some evidence that there is less chance of abnormality in the offspring than if the children are conceived at once.

THE ROENTGEN DIAGNOSIS OF NEOPLASMS OF THE AIR AND FOOD PASSAGES, WITH PARTICULAR REFERENCE TO THE LARYNX¹

By EUGENE P. PENDERGRASS, M.D., and BARTON R. YOUNG, M.D., *Philadelphia*

From the Departments of Radiology of the Hospitals of the University of Pennsylvania and of Temple University

THE roentgen diagnosis of lesions within and adjacent to the larynx is now an established procedure. Formerly, lateral views of the neck, careful fluoroscopic examinations in the lateral and sagittal planes during phonation and during the swallowing act, with and without opaque mixtures, were regarded as a complete roentgen examination.

More recently, however, through the investigation of Young (1, 2), conventional short target-film distance roentgenograms made in the sagittal plane have revealed additional information concerning, particularly, subglottic extensions of neoplasms and afford confirmatory informa-

tion as to the laterality of the lesion. In 1936, Le Borgne (3, 4) demonstrated the value of body-section roentgenography (planigraphy) in diagnosing lesions of the larynx and contiguous structures. It is too early, as yet, to predict the value of this procedure, but thus far it has revealed information that was impossible to obtain by other diagnostic procedures.

The basis for diagnostic ability in the region of the larynx is a qualified familiarity with the anatomy of all the contained structures and their boundaries; of their normal roentgenologic appearance; of their normal range of mobility, if motile; and of their physiologic processes.

Roentgenologic and Anatomic Considerations of the Normal Pharynx.—The oral and laryngeal pharynx in the adult are the

¹ Presented before the International Cancer Congress, at Atlantic City, N. J., Sept. 11-16, 1939.



Fig. 1.

Fig. 1. Lateral view of the *oral pharynx*. The nasal pharynx is seen at *a*; the soft palate at *b*; the oral pharynx at *c*, and the posterior pharyngeal wall at *d*.

Fig. 2. Lateral view of the *oral pharynx* made during phonation. The soft palate, at *b*, completely separates the nasal and oral pharynges. The nasal pharynx is at *a*, and the oral pharynx at *c*.



Fig. 2.

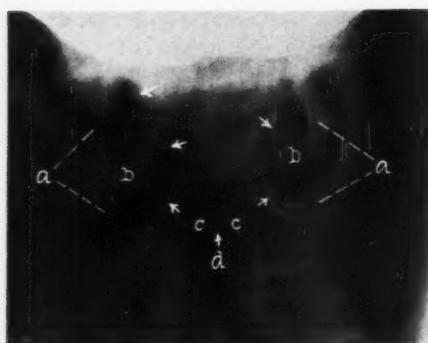


Fig. 3. Lamina of thyroid cartilage at *a*, pyriform sinuses at *b*. The right pyriform sinus is demarcated by arrows, the left contains a small amount of barium. The shadows of the true vocal cords are seen at *c* and the glottis at *d*. The film made in the postero-anterior position at close distance and during phonation.

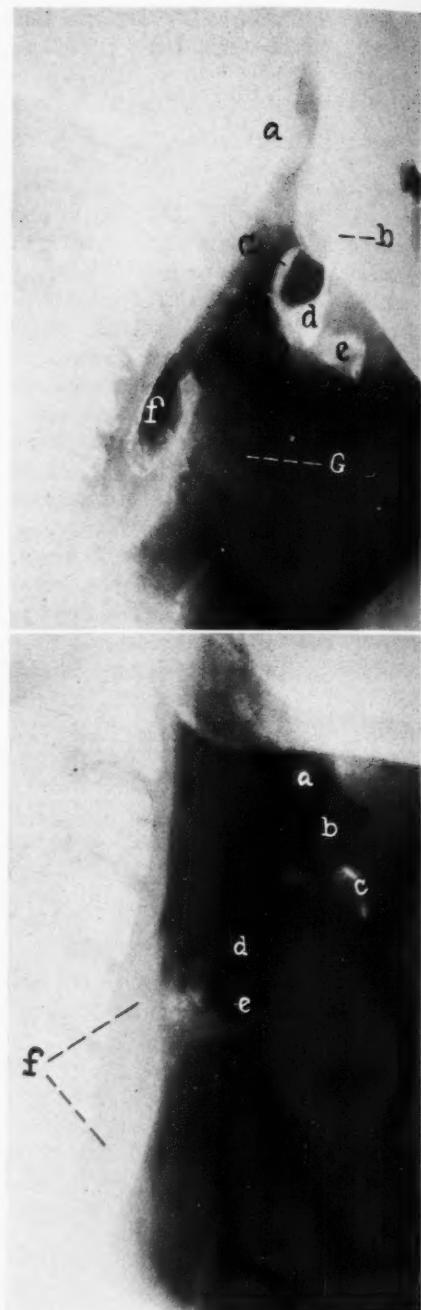


Fig. 4 (above). Lateral view of the neck made shortly after the patient was given a liquid suspension of barium. The posterior pharyngeal wall shadow is seen at *a*; the base of the tongue at *b*; the epiglottis at *c*; the valleculæ, which contain barium, at *d*; the hyoid at *e*; the pyriform sinuses at *f*, and the laryngeal ventricles at *g*.

only portions of the food passage which will be discussed.

The cavity of the *oral pharynx* is more or less rectangular in shape. It is bounded above, during phonation, by the inferior surface of the soft palate; anteriorly, by the base of the tongue; posteriorly, by the posterior pharyngeal wall, and inferiorly, by the valleculæ, epiglottis, structures of the superior laryngeal aperture, and laryngeal pharynx (Figs. 1 and 2).

The superior aspect of the oral pharynx is changeable, depending on whether or not the patient is phonating. During phonation, the soft palate obstructs the communication between the oral pharynx and the nasal pharynx. The anterior aspect of the oral pharynx is made up largely of the posterior surface of the tongue, the shadow of which is somewhat hazy in outline, due to the papillæ on its mucosal surface. The tongue shadow presents a gradual curvature posteriorly and downward until it reaches the valleculæ, which lie between the base of the tongue and the epiglottis. This is usually opposite the body of the third cervical vertebra. Here, the base of the tongue merges into the inferior limits of the oral pharynx, whence there is an abrupt curvature in the anterior direction, with the

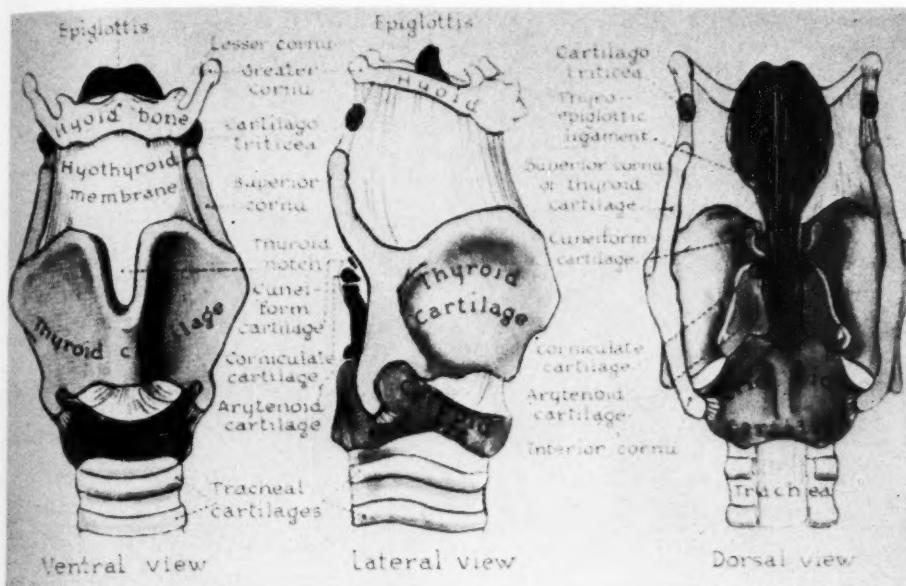


Fig. 6. Illustration showing cartilages of larynx. (Shown through the courtesy of Pancoast, Pendergrass, and Schaeffer, "Roentgen Diagnosis of Head and Neck," Charles C. Thomas, Springfield, Ill., publisher.)

posterior surface of the tongue terminating in the epiglottic valleculæ (Fig. 4). The body of the hyoid bone lies a short distance anterior to the epiglottic valleculæ; and the greater cornua pass posteriorly and upward, superimposed upon the shadow of the valleculæ. The body of the hyoid bone usually lies on a level with the upper border of the fourth cervical vertebra, but its level varies with the degree of the tilt of the head and the act of swallowing. The posterior wall of the pharynx appears as a homogeneous, band-like structure of about average soft-tissue density, clean-cut in outline, and running parallel with the anterior surfaces of the cervical vertebrae until reaching a point just above its lowest visible extent (Fig. 4). The retro-

at g. Ordinarily, the lower portion of the pyriform sinuses are collapsed except when they are participating in the swallowing act, but may be seen during inspiration in infants, and during rest in older individuals.

Fig. 5 (below). Lateral view of a normal neck. The shadow of the epiglottis seen at a; the valleculæ at b; the hyoid at c; the vestibule of the larynx at d; the ventricles of the larynx at e, and the retrolaryngeal and retrotracheal spaces at f.

pharyngeal structures vary in thickness but in children and adults they are more or less uniformly thick, extending upward from the level of the arytenoids into the nasal pharynx. Any variation in the thickness of these structures can be regarded as pathologic.

All of these structures can be studied satisfactorily in the lateral plane.

The *laryngeal pharynx* connects the oral pharynx above with the beginning of the esophagus below, the latter at the level of the sixth cervical vertebra and the lower border of the cricoid cartilage. The dorsal wall of the laryngeal pharynx is in intimate relationship with the bony vertebral column, while the ventral wall is in contact with the dorsal wall of the larynx, containing the arytenoid cartilages and the lamina of the cricoid cartilage. The lateral walls of the laryngeal pharynx are attached to the thyroid cartilage and to the hyoid bone. Above and in the median plane is the epiglottis, which guards the superior laryngeal aperture beneath it. On either side of the laryngeal pharynx, below the

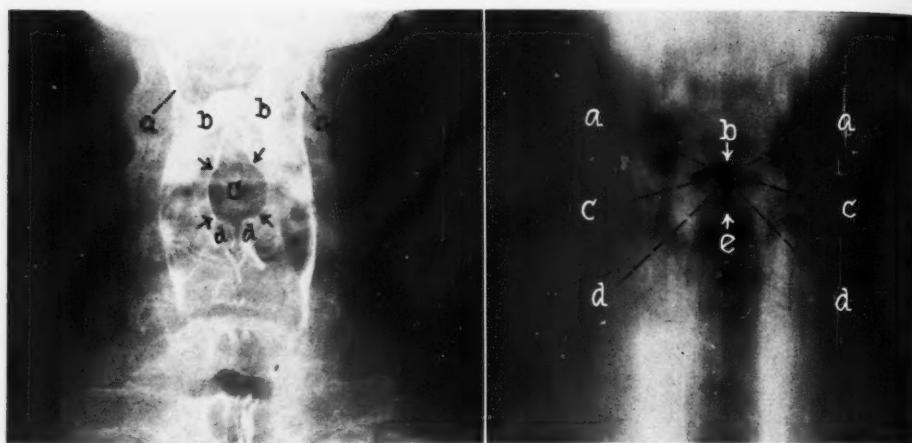


Fig. 7.

Fig. 8.

Fig. 7. Conventional anteroposterior roentgenogram of the neck, made during phonation, following the swallowing of a suspension of barium in water. The boundaries of the lateral walls of the *oral pharynx* are seen at *a*; the valleculæ at *b*; the superior aperture of the larynx which communicates with the laryngeal vestibule at *c*, and the arytenoid cartilages are at *d*.

Fig. 8. Body-section roentgenogram of normal larynx, the ventricular bands at *a*; the space between the ventricular bands at *b*; the laryngeal ventricles at *c*; the true vocal cords at *d*; the glottis at *e*. The air spaces just referred to produce a shadow similar to that of a "jackstone."

level of the pharyngo-epiglottic fold, is the elongated *pyriform recess* (pyriform sinus), bounded laterally by the medial surface of the thyroid cartilage (Figs. 3 and 4).

The only portions of the laryngeal pharynx which can be seen without the aid of an opaque medium are the pyriform recesses (Fig. 4). Elsewhere, these structures, which are muscular and collapsed except during swallowing or in disease, occupy the retrolaryngeal and retrotracheal space. The retrolaryngeal and retrotracheal spaces remain relatively uniform from their upper level (top of arytenoid cartilages) to that of the clavicle (Fig. 5).

In the lateral view, the shadows of the pyriform recesses (pyriform sinuses) are roughly oval in shape (Fig. 4), with the anterior border convex anteriorly and the posterior border relatively straight. Their shadows superimpose somewhat the posterior and upper aspects of the laryngeal shadow (Fig. 4). In the postero-anterior view, the pyriform sinus is present on either side, just mesial to the lamina of the thyroid cartilage (Fig. 3.) These

structures will be commented upon again during a discussion of the fluoroscopic examination.

Roentgenologic and Anatomic Considerations of the Normal Larynx and Trachea.—The larynx and trachea join to form a tubular structure which can be seen readily by appropriate roentgen examinations, due to the fact that under normal circumstances many of the component parts are outlined by air.

The epiglottic valleculæ are spaces which lie between the base of the tongue anteriorly and the cephalic end of the epiglottis posteriorly. They are of equal size, and symmetrically placed to either side of the mid-sagittal plane of the neck. Visualization of these spaces is possible in the lateral view without the use of opaque mixtures, as they usually contain air (Fig. 5), but more information is obtained by studying them in the sagittal plane during the ingestion of a suspension of barium in water.

Their appearance in this plane is that of two shallow pouches located just to either side of the midline, the inferior

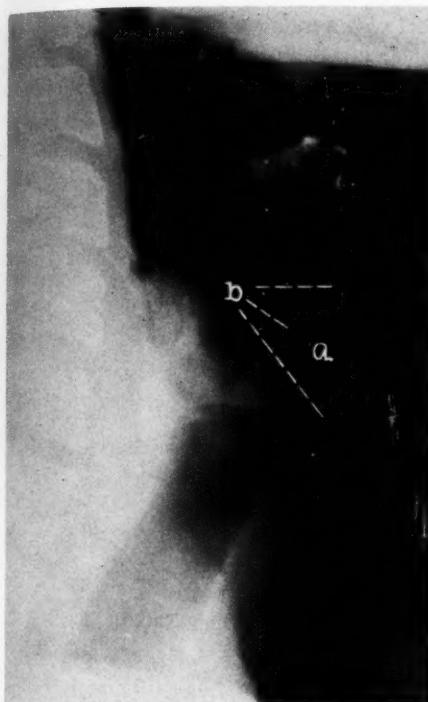


Fig. 9.

Fig. 9. The clear zone at *a* is due to lack of ossification in the thyroid cartilage and not to disease. The zone of increased density at *b* is due to the normal process of ossification.

Fig. 10. Lateral view of neck. The shadow of a styloid process is seen at *a*; the cartilago triticea at *b*; the hyoid bone at *c*; the thyroid cartilage at *d*; calcification in the arytenoid cartilage at *e*; the cricoid cartilage at *f*, and the laryngeal ventricles at *g*. The cartilages of the larynx show an unusual amount of calcification and ossification. Shadows such as those produced by the triticea cartilage and the cricoid may simulate those produced by some opaque foreign bodies.

borders being rounded and the superior borders being straight (produced by the air and fluid level of the opaque suspension). (See Figure 16.)

The epiglottis is situated behind the root of the tongue and the body of the hyoid bone, and in front of the superior entrance of the larynx. The lower end of this cartilage tapers into a short stalk to which the thyro-epiglottic ligament is attached. The structure is leaf-shaped with a free cephalic end or tip that is exceptionally well visualized by the lateral roentgenogram because of the air content of the pharynx and larynx (Fig. 4). Change in shape or size of this structure is indicative of disease, either inflammatory or neoplastic in nature.

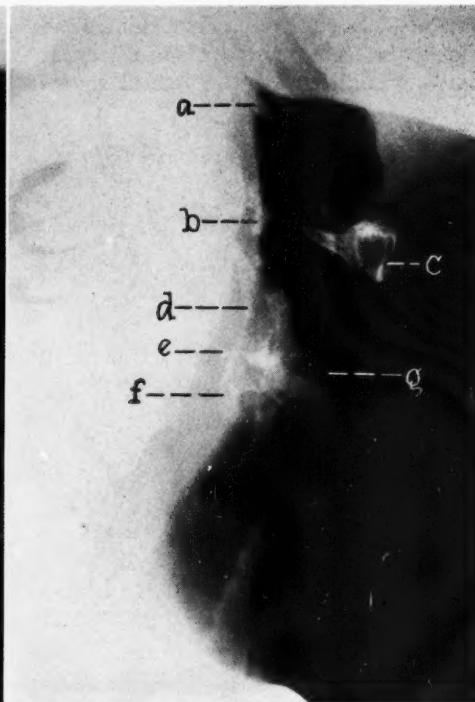


Fig. 10.



Fig. 11. Photograph of the tube against the patient's neck for a close-up view of the larynx.

Immediately below and behind the epiglottis is the *vestibule* of the larynx, which is visualized by the lateral roent-

geal vestibule varies considerably in the male, but this is not true in the female. The shadow of the aryepiglottic folds ex-

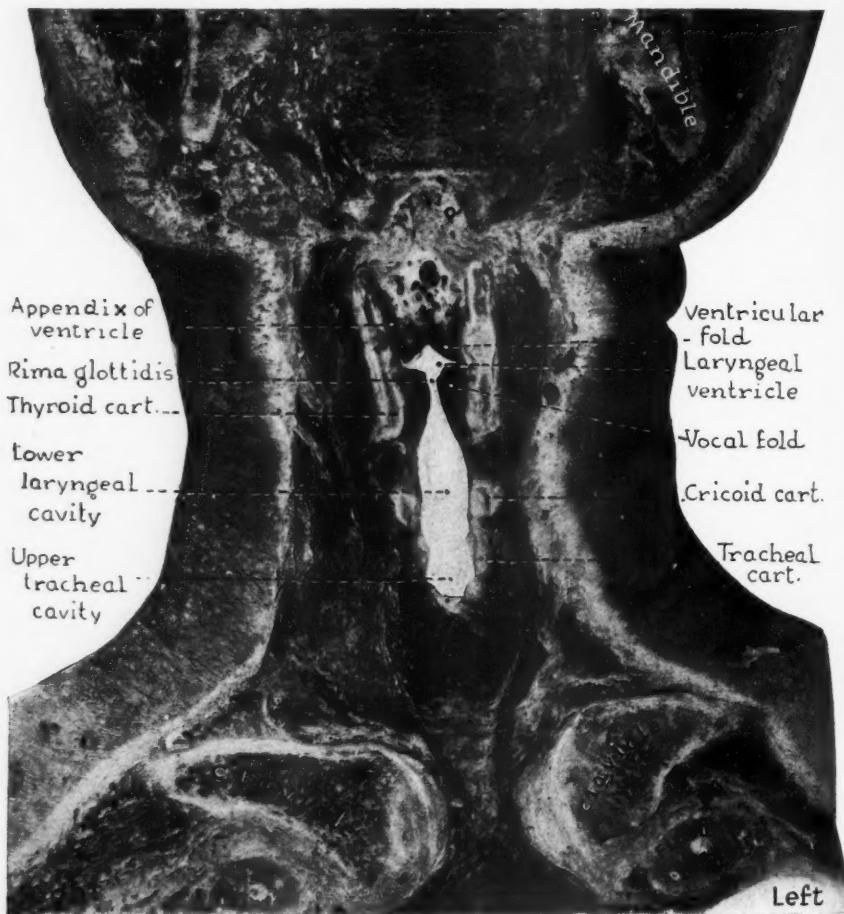


Fig. 12. This represents an anteroposterior view of the structures of the neck, etc., sectioned 12 mm. in depth from the surface-marking of the laryngeal prominence, cutting through the ventral end of the vocal folds, with the forward portion of the rima glottidis between them.

(Figures 12 to 15 are from photographs of serial frontal or coronal sections of the head and neck of an adult negro, viewed either anteroposteriorly or postero-anteriorly, and are shown through the courtesy of Pancoast, Pendergrass, and Schaeffer, "Roentgen Diagnosis of Head and Neck," Charles C. Thomas, Springfield, Ill., publisher.)

genogram as an irregularly elongated triangular air space, bounded below by the ventricular bands, the arytenoid masses posteriorly, in front by the posterior border of the epiglottis, and above by the aryepiglottic folds and cuneiform and corniculate cartilages (Fig. 5). The laryn-

tends obliquely downward from the posterior part of the epiglottis to the arytenoid cartilages. The posterior margins of these folds are sharply defined in the lateral roentgenogram, and, because a true lateral produces super-position of the shadow of one upon the other, they are

best seen if the patient is rotated from five to ten degrees.

Since the development of body-section

The shadows of the *laryngeal ventricles* are superimposed upon each other in the lateral view and are "zeppelin-shaped."

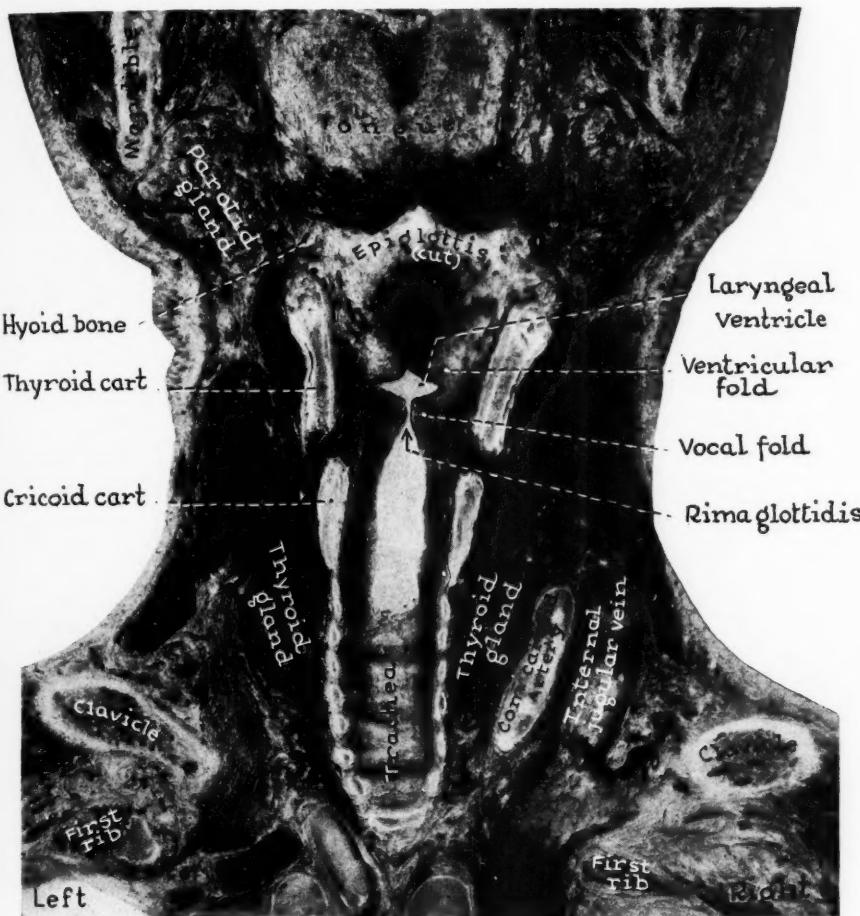


Fig. 13. In this, the plane of sections falls 11 mm. deeper than in Figure 12, viewed from behind forward, that is, postero-anteriorly.

roentgenography, it has become possible to visualize the vestibule without the aid of opaque media. In conventional antero-posterior roentgenograms, an opaque medium is required to delineate the boundaries of the vestibule in order to recognize its shadow on the roentgenogram. The shadow of the vestibule is pear-shaped during phonation and after the swallowing act (Fig. 7). Any deformation of that shadow is regarded as abnormal.

The ventricles are located in the anterior three-fifths of the larynx, bounded above by the false and below by the true cords (Fig. 5). The false cords are homogeneous band-like structures, horizontally placed, with rather clean-cut curved lower margins and concavity directed downward. The shadows of the upper borders of these structures are ill defined as they gradually shade off into the vestibule above. The true cords are larger and more dense than

the false cords and are, therefore, better visualized roentgenologically. Any disturbance in the outline of the cords is

tricles is, in most instances, best seen during the phonation of "e," and is normally visualized in the sagittal and lateral

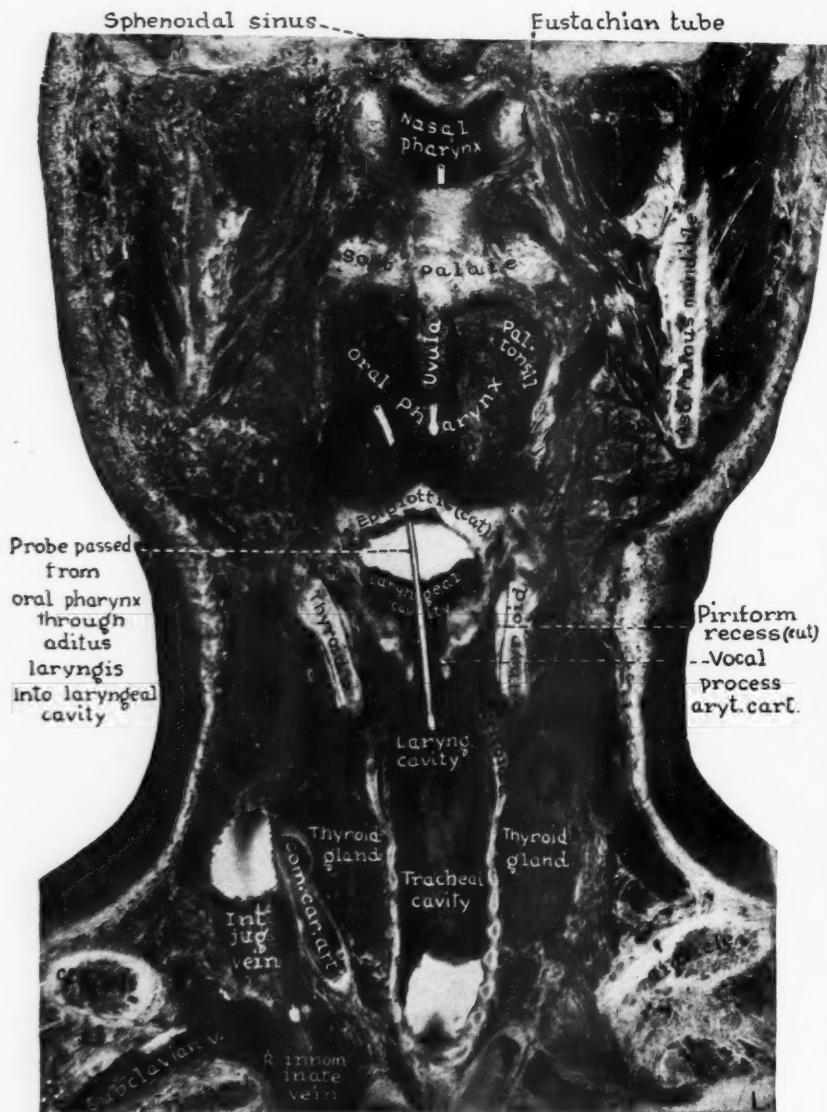


Fig. 14. This plane is at the same depth as in Figure 13, but the surface of the section, next in order, is viewed from before backward, that is, anteroposteriorly.

readily demonstrated by encroachment on the ventricular spaces or the air space beneath them. The shadow of the ven-

roentgenograms unless there is extensive ossification of the laminæ of the thyroid cartilage.

In the postero-anterior view (close distance) and in the body-section roentgenogram, the shadows of the laryngeal ven-

Calcification and ossification begin normally in the laminæ of the thyroid cartilage at about the age of 20 years and

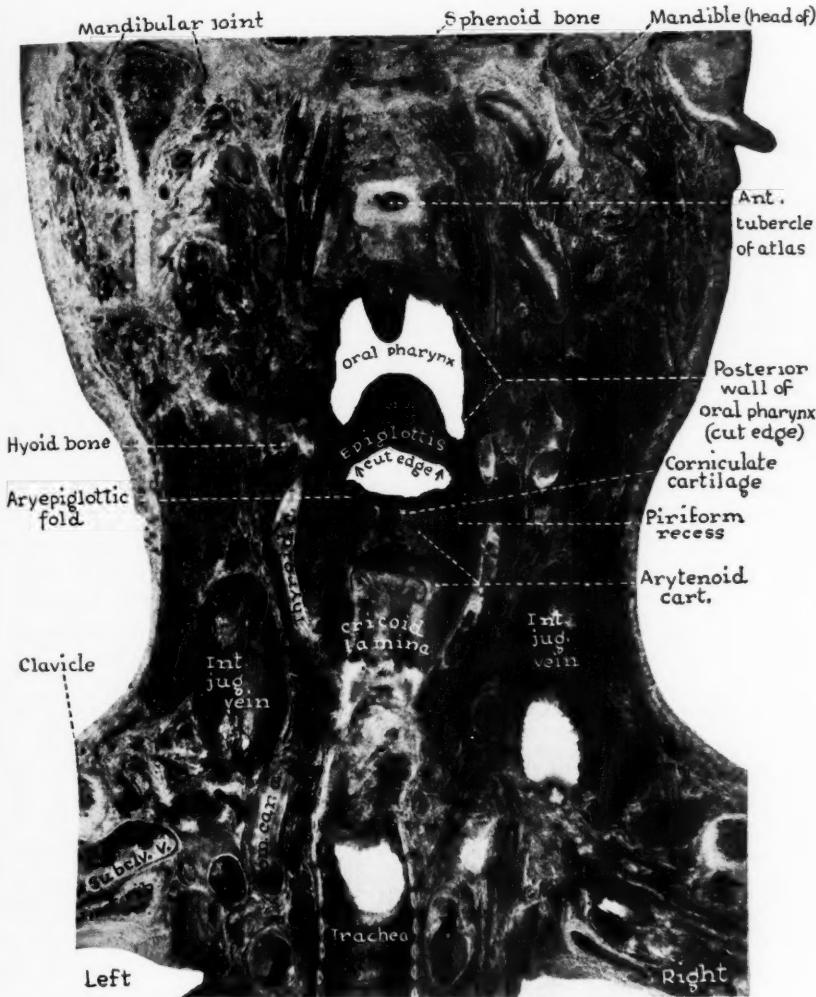


Fig. 15. This is the posterior (dorsal) surface, 11.5 mm. deeper, of the section of which the ventral surface is illustrated in Figure 14, viewed from behind forward, that is, postero-anteriorly.

tricles have an appearance similar to the horizontal members of a "jackstone." The space between the true cords (glottis) produces a shadow similar to the inferior member of the "jackstone" and the space between the ventricular bands produces the superior member (Fig. 8).

progress slowly and irregularly throughout the cartilage, with the exception of the median portion. Bone formation is more extensive in the male, and, when pronounced, it interferes with the visualization of the shadow of the ventricles. Since the bone is laid down in an irregular pat-

tern, large unossified areas are occasionally seen in the adult male thyroid cartilage (Figs. 6, 9, 10). In the past these ossified areas have been misinterpreted as an area of destruction during the observation and treatment of cancer of the larynx. In the anteroposterior view, ossification of the thyroid cartilage may be recognized as seen in Figure 3.

Technic.—In all roentgen examinations of the air and food passages, fluoroscopy is the first procedure. The eyes of the operator must be well accommodated and adapted. In beginning the fluoroscopy, one should make a general inspection of the entire field in the lateral and sagittal planes with the head and neck symmetrically placed.

The next procedure is directed toward determining the integrity of the motor mechanism of the soft palate, the tongue, and the pharynx. The soft palate should contract freely during the act of whistling or phonation. Any variation due to faulty innervation or infiltration from a growth; disturbed innervation resulting in an abnormality in the movement of the structure, and a neoplastic process causing an enlargement of the shadow of the soft palate in addition to a reduced mobility can be observed readily.

The contour and mobility of the tongue is then studied by having the patient protrude the tongue from the mouth and likewise observing its movements during the swallowing act, with and without the use of an opaque medium. Growths of the base of the tongue will cause limitation of motion and slight disturbances in the swallowing act. If the lesion is ulcerated, craters can be readily outlined with a suspension of barium.

Pharyngeal lesions, if situated in the oral portion, cast a shadow and will encroach on the normal air space of that structure. If the tumor infiltrates the surrounding structures, slight to marked disturbances in the swallowing act may occur. This portion of the pharynx is studied best in the lateral plane. If the laryngeal pharynx is involved, the shadow

of the retrolaryngeal and retrotracheal space may increase in its anteroposterior dimension. The magnitude of disturbance of deglutition depends upon the position and size of the growth. This portion of the pharynx should be studied in both views, as in the sagittal plane one can determine with greater ease whether one or both pyriform recesses are involved.

The larynx is observed in the lateral and sagittal planes. The patient is required to pronounce certain vowels in order that the changes in the appearance of the arytenoid cartilages, the ventricular folds, the vocal cords, and the laryngeal ventricles might be noted. The shadows of the air-containing "zeppelin-shaped" cavities of the superimposed ventricles should be clearly shown in the lateral view, if the larynx be normal. In the sagittal plane, the laryngeal ventricles are readily seen and their normal appearance is shown in Figure 8. When no deformity is seen, any severe inflammatory condition in the larynx or any growth in the region of the vocal cords or paralysis is practically excluded. When the air-containing cavity of the ventricles is not visible, the presence of growth, inflammatory process, or paralysis of the vocal cords may be assumed. The air space below the vocal cords is well defined and its upper border is fairly straight, if there is nothing abnormal with the vocal cords.

The shadows of the arytenoids are seen easily in the normal subject in both planes because they are well surrounded by air. They are under control of practically the entire musculature of the larynx, and subject to lateral and sagittal movements which vary considerably in appearance and position in the roentgenogram. These cartilages may appear thick, thin, or sharply defined under different circumstances. Fluoroscopic observations of their motility and configuration are necessary in the final interpretation. Study of the swallowing act, after employing an opaque medium, will greatly assist one in the study of the arytenoids and the adjacent structures.

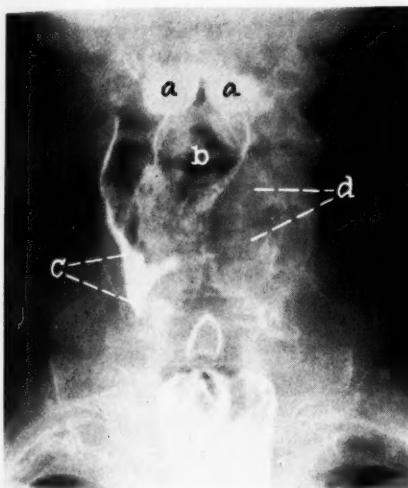


Fig. 16.

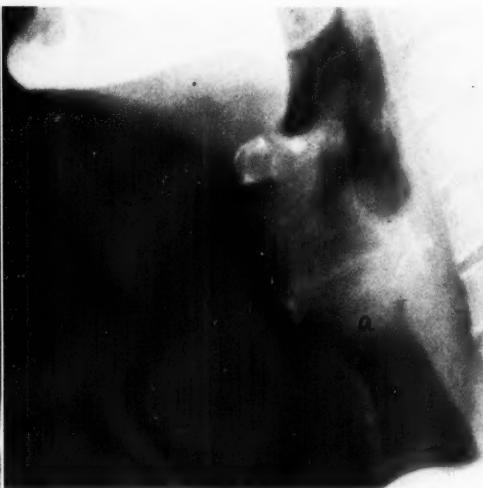


Fig. 17.

Fig. 16. Carcinoma of larynx involving the pyriform sinus on left side. The vallecula at *a*; the vestibule of the larynx at *b*; the normal pyriform sinus at *c*; the area occupied by growth obliterating the left pyriform sinus at *d*.

Fig. 17. Carcinoma of one of the true vocal cords. The shadow of the laryngeal ventricles is not seen. The shadow of the growth is seen at *a*.

The Normal Swallowing Act.—This physiologic process may be divided into four stages:

1. Filling of the mouth and movement of the base of the tongue backward toward the post-pharyngeal wall.
2. As the bolus begins to move backward from the mouth, the base of the tongue comes against the post-pharyngeal wall and the epiglottis goes backward and downward. Simultaneously, the larynx rises and the arytenoid cartilages come in contact with the under surface of the epiglottis so that the tongue, epiglottis, and arytenoids form a single homogeneous shadow. The meeting of these three structures closes off the air passage in the larynx.
3. As seen fluoroscopically, the bolus of food then enters the pharynx and immediately passes down into and through the esophagus. This movement is so rapid that the exact action of the structures concerned cannot be determined.
4. Return of all structures to the rest position as the bolus disappears down the esophagus.

It is entirely possible that one may wish to obtain roentgenograms before any opaque mixtures are administered to the patient. In such instances, the fluoroscopy concerned with the swallowing act may be delayed until the roentgenograms are made.

After completing the fluoroscopy, roentgenograms should be made in positions which will assist in the diagnosis. These positions will be discussed in greater detail under the heading of the various lesions.

In making a roentgenogram of the neck in the lateral plane, the patient may be examined in the erect or horizontal posture. The most satisfactory method, perhaps, is to have the patient sit erect with the shoulders drooping. It may be necessary to instruct the patient to grasp the chair with both hands in order to pull the shoulders down sufficiently. A 10×12 or an 8×10 film is placed laterally to the shoulder. The central ray is directed in the lateral direction in the line of the thyroid cartilage. The patient's head



Fig. 18. Carcinoma of the larynx extending into a subglottic region at *a*.

should be placed in the medial anatomic position and not permitted to tilt from side to side. This projection does cause some distortion of the soft-tissue structures, but, on the whole, is a most satisfactory one. A film may be placed laterally to the head or at the side of the neck, if the pharynx or larynx is to be demonstrated particularly. Such methods result in finer detail in the roentgenograms. Roentgenograms of the larynx should be made during the patient's phonation of the vowel "e" to permit visualization of the laryngeal ventricles.

In order to obtain maximum detail in all structures, it is necessary to use at least two types of exposure; one for the demonstration of soft-tissue detail, and the other for bony detail.

Structures Seen in the Roentgenogram Made in the Conventional Anteroposterior or Postero-anterior View.—In cases in which the field of exposure extends from the chin to the clavicles, the skin, subcutaneous tissue, muscles, and glands merge to form a composite shadow. There is very little differentiation of the tissues unless the patient is fat, in which instance, definite differences prevail between skin, subcutaneous structures, and muscles. The thyroid gland is usually not revealed unless it be abnormal. The trachea and larynx are well portrayed and superimposed upon the cervical spine in the medial

plane, with the neck symmetrically placed. Unless the patient is old, and there is some calcification of the tracheal and laryngeal cartilages, the junction of the trachea and larynx is not well defined. Ossification of the thyroid cartilage, which is superimposed upon the spine in the antero-posterior view, may be confusing. The value of this view is to determine encroachment upon, or displacement of, the trachea, calcification of the thyroid gland and lymphatic nodes, subcutaneous emphysema, or inflammatory changes.

If an opaque medium is employed, either anteroposterior or postero-anterior roentgenograms should be made in the erect posture using conventional film-target distances. The exposures should be made during or immediately after the swallowing act, the choice depending upon the fluoroscopic observations.

Close Distance Postero-anterior View.—Demonstration of the larynx and adjacent structures in the sagittal plane was impossible until the advent of fine focus shock-proof x-ray tube. Since that time, roentgenograms have been exposed in the postero-anterior direction, at close range, placing the tube against the back of the neck and the film in contact with the ventral surface of the neck. The target-skin distance must be short (approximately 10 cm.) in order to produce blurring of the spine shadow. The target-film distance is likewise short and represents the postero-anterior dimension of the neck plus the target-skin distance (Fig. 11). The chin is slightly elevated to a predetermined position (at the time of fluoroscopy) to obviate the superimposition of the mandible upon the structures of the neck and to obtain the ventricles in an axial plane.

The factors employed are as follows: voltage, varying from 45 to 50 kv.p.; milliamperage, 300, and time, one-twentieth of a second. Films are exposed during phonation of "e" and while holding the breath. Roentgenograms obtained by this technic show the aryepiglottic folds, true and false cords, and their range of motion,



Fig. 19.



Fig. 20.

Fig. 19. Carcinoma of the larynx. The shadow of the growth encroaches on the lumen of the larynx at *a* and extends into the subglottic region at *b*.

Fig. 20. Carcinoma of larynx in lateral view. The only evidence of carcinoma was the absence of the shadow of the ventricles of the larynx.

and the ventricles between them, the pyriform sinuses, subglottic region, and cervical trachea. Since many of these structures are paired, it is easy to lateralize a lesion and demonstrate any side-to-side deviation of the airway and food passage. These short target-film distance roentgenograms are inferior in detail to body-section roentgenograms, but they serve as excellent substitutes when it is impossible to carry out planigraphic studies.

Body-section Roentgenograms.—This procedure has proved to be invaluable for roentgen visualization of the soft tissues of the larynx and adjacent structures in the sagittal plane. Our experience indicates that simultaneous movement of the x-ray tube and Potter-Bucky diaphragm in opposite directions in a straight line is satisfactory for production of good quality roentgenograms. The tube and film move in horizontal planes which are, therefore, parallel to each other and to the plane of

the body under examination. The tube tilts sufficiently during its travel so that the central beam is directed at the middle of the film throughout the exposure. Success in demonstrating a lesion depends upon the selection of the proper plane of the body for examination. As a preliminary procedure, we expose a lateral roentgenogram of the neck and measure the depth of the lesion before carrying out body-section studies. Films must be exposed not only at the estimated level of the lesion but of adjacent superior and inferior planes as well, in order to be certain that the extent of the lesion is recorded. We make exposures at from four to five different levels, varying each step one-half centimeter because this figure represents the thickness of the layer of tissue in focus during the exposure (Figs. 8, 12, 13, 14, 15).

Body-section studies are valuable in the diagnosis of both benign and malignant

lesions. Small discrete benign tumors, paralysis of the cords due to injury of the recurrent nerve, and laryngocoele are some of the benign abnormalities which may be revealed by this procedure. This method is particularly valuable when dealing with subglottic malignant neoplasms of the larynx because the configuration of the tumor and its relation to surrounding structures are demonstrated better by body-section roentgenography than by any other procedure. We have found these studies to be valuable in arriving at a decision as to whether a laryngeal neoplasm should be treated by surgery or irradiation.

Roentgenologic Consideration of Neoplasms of the Upper Food Passages.—*Soft Palate.* Any growth that involves the soft palate causes swelling and thickening of that structure, with more or less fixation, so that the patient is unable to obtain a normal range of movement if he attempts to whistle or phonate. If an attempt is

made by the patient to swallow a thin suspension of barium, the opaque solution may run out of the nose, due to the partial fixation caused by the swelling. This will, likewise, occur in paralyses of the soft palate.

Tongue. Malignant growths on the back or at the base of the tongue interfere with its movement. The patient may be unable properly to protrude this organ from the mouth. The swallowing function is more or less disturbed. Malignant growths in this region are particularly apt to infiltrate and to form craters. Other malignant growths in this vicinity produce rounded swellings and cannot be differentiated from such conditions and lesions as the lingual thyroids or cysts.

Oral Pharynx. Growths in this region, involving the posterior pharyngeal wall, will produce blurring of the pharyngeal air shadow and a thickening of the posterior pharyngeal structures. If the growth is malignant and comparatively recent, it is apt to cause more thickening on one side of the pharynx and thus produce a double soft-tissue shadow in the lateral roentgenogram. Retropharyngeal lesions are more likely to cast a shadow that is regular in outline. The swallowing function may be considerably interfered with.

Laryngeal Pharynx. If one or the other pyriform recess or sinus is involved, its outline will be indefinite. A malignant process may so disturb this portion of the pharynx that the recess becomes quite shallow, or even obliterated. In either case, the swallowing function is greatly disturbed. Growths in this region often extend to and actually invade the adjacent laryngeal structures, or *vice versa*. These lesions, when unilateral, are often seen best in the postero-anterior roentgenograms (Fig. 16).

Roentgenologic Consideration of Neoplasms of the Larynx.—Enlargement or change in contour of the soft tissues of the extrinsic larynx are best visualized by the lateral study. Distortion of the epiglottis due to a tumor, or the unusual fullness of the aryepiglottic folds produced by a



Fig. 21. Body-section roentgenogram showing carcinoma of the larynx. Right side, at *a*, is normal. The ventricular band is considerably enlarged at *b*. The left ventricle is quite shallow at *c*. The left true vocal cord, at *d*, is considerably enlarged by a growth which extends into the subglottic region at *e*.

neoplasm, is readily detected by a study of the lateral roentgenogram.

Tumors arising in the ventricular bands may extend cephalad into the vestibule of the larynx or caudad so as to encroach upon the ventricles.

Neoplasms occurring in this region are frequently malignant. It should be borne in mind, however, that laryngocles may produce large soft-tissue shadows on the conventional roentgenograms. Likewise, on direct or indirect laryngoscopic examinations, a laryngocle may be mistaken for a large carcinoma. The true nature of such lesions may be revealed by appropriate body-section roentgenographic studies if the neoplasm contains air.

Failure of visualization of the laryngeal ventricles in the lateral view indicates some abnormality unless excessive ossification in the thyroid cartilage is the interfering factor. It is oftentimes impossible to state from the roentgen evidence alone whether the obliteration of the ventricle is due to a neoplastic or non-neoplastic process. Provided there is a good deal of distortion of the cords and considerable soft-tissue swelling, a tentative diagnosis of tumor is warranted. It is quite difficult and often impossible to make a roentgen diagnosis of carcinoma if the lesion is not extensive. In the lateral view, carcinoma of the larynx may deform the air shadow of the subglottic larynx (Figs. 17, 19). These deformities vary with the extent and nature of the process.

Small benign tumors of the cords, such as papillomas and fibromas, are well visualized by both lateral and sagittal roentgenograms because all of the tumor, except that point which attaches to the cord, is thrown into relief by the surrounding air.

Carcinoma involving the vocal cords frequently extends into the subglottic region. It is in the demonstration of this extension that body-section roentgenography plays a pre-eminent rôle. Oftentimes it is impossible to obtain the information otherwise. The deformities demonstrable are quite variable, depending upon the site and extent of the lesion. If one is informed as to the normal, detection of the abnormal becomes relatively simple (Figs. 18, 20, and 21).

A frequent roentgen finding in disease of the intrinsic larynx is enlargement of one or both arytenoid masses. In a true lateral roentgenogram, only one arytenoid shadow is visualized. Normally, these structures which lie just back of the posterior extremities of the cords are difficult to differentiate from adjacent tissue except during movement, but their composite shadow appears as a spherical mass if inflammatory or neoplastic laryngeal disease exists.

Summary.—This discussion has included (1) a detailed description of the roentgenologic appearance of the normal pharynx and larynx; (2) the roentgen technic employed in the examination of these structures, stressing particularly the procedure of body-section roentgenography, and (3) a description of some of the neoplastic lesions involving these structures.

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THE COPYING OF ROENTGENOGRAMS^{1,2}

By G. M. BUSANOVICH, *Philadelphia*

ROENTGENOGRAMS may be reproduced by direct contact printing, direct duplication, chemical reversal, or photographic reduction. The last is the most satisfactory method for most purposes and particularly for publication. From the negative roentgenogram a reduced positive is made, and the negative final copy is produced by contact printing or projection of the intermediate positive. This method is commonly used in making paper prints, and also film transparencies. It has been used by the writer for both purposes, in preparing material for publication and exhibition by F. Maurice McPhedran, M.D.

Reduction.—In this paper only the reduction method will be discussed. Roentgenograms may be reduced to positives ranging in size from 8×10 in. down to the 1×1.5 in. or 35 mm. film. This last produces copies at the lowest cost, but inferior results were obtained when the method was first introduced, and the technic is still being improved. In any reduction, whether paper or transparency, there will always be some detail not so clearly shown as in the original x-ray film. This is partly due to the difference in size between the copy and the roentgenogram and, other factors being equal, the greater the discrepancy, the greater will be the loss of detail. Again, in going through the press, a further loss of photographic detail will be caused by the photo-mechanical reproduction. It is, therefore, very important to choose the method of copying which will reproduce the greatest detail, and considerations of cost should be

weighed against the major consideration of accuracy.

Contact Printing.—In printing the intermediate positive, only the contact method will give good detail and brilliance in the final copy, especially with paper prints. With projection, the print is less sharp, and there is less control of detail by dodging. The faults of projection limit useful sizes for reduction to a range from 4×5 up to 8×10 inches.

THE INTERMEDIATE POSITIVE

Choice of Film.—Types of film generally used for photographic copy work are commercial, process, commercial orthochromatic, portrait orthochromatic, and sometimes panchromatic emulsions. Since roentgenograms contain no colors but only gradations of black to white, a non-color-sensitive medium is indicated, that is, of those enumerated, commercial or process film. The best results are obtained with the one or the other of these, although good results are given by portrait orthochromatic film used in conjunction with x-ray developer. Choice between the first two depends upon the degree of contrast in the original and that desired in the copy, which is further controlled by the choice of developer. Actually, commercial film is used in the majority of cases. Process film is employed only for roentgenograms which are very thin or weak (low density and contrast). It has been observed in practice, and recently White (1) has shown graphically, that the commercial type film comes closest to theoretical perfection in the reproduction of roentgenograms of average contrast.

Choice of Developer.—The choice of developer, or of film, may be considered particularly with respect to contrast. The first object of the photographer is, of course, to secure richness and clearness of

¹ Presented before the Salon of the Biological Photographic Association at Milwaukee, Sept. 13, 1940.

² From the Research Department of Respiratory Diseases of the Germantown Hospital, Philadelphia; prepared with the aid of Miss Eleanor S. Cooper, research editor.

detail, which is controlled chiefly by the exposure technic. Aside from this requisite, the prime object in copy work is to attain the contrast desired in the copy, which may be equal to, or lower or higher than, that in the original. If the factors which adversely influence photographic detail (2) are ruled out, copying can be simplified by directing full attention to contrast.

Contrast in the intermediate depends upon the film, the developer, and the length of development. It is further modified in the paper print, mostly by the grade of paper chosen and by dodging, as described below. Developers, like film, may be rated as giving low, medium, and high contrast, and the range obtainable in the positive is limited by the choice of film and developer, modified by under- or over-development, and also by dodging. In practice it has been found that in most copy work the best results are obtained with medium film (commercial) and a low-contrast developer. When, however, not enough contrast is obtained with these even by over-development, a high-contrast developer should be used. In copying exceptionally flat roentgenograms, a film of exceptionally high contrast (process) must be chosen, and used with the type of developer which proves to be most suitable.

Chart I indicates roughly the requirements for roentgenograms of varying degrees of contrast. Actually, there are some x-ray films which do not fall within these groups but somewhere between them. In such cases the correct result can be readily obtained by remembering that, given the type of film and developer that most closely approach the desired effect, the degree of contrast is finally controlled by the length of development.

Equipment for Copying.—In making the intermediate, x-ray illuminators may be used for transillumination of the roentgenogram, but it is much more convenient and satisfactory to have a box especially built for copy work. On the front of the box there should be a hinged door of clear

CHART I.—TO OBTAIN CORRECT CONTRAST IN THE INTERMEDIATE POSITIVE

Contrast in Roentgenogram	Choice of Film	Developer and Development
Very high	Commercial	Under-development in low-contrast developer, such as D-76, ND-2, Agfa 17
High	Commercial	Slight under-development in low-contrast developer
Average	Commercial	Average development in low-contrast developer
Low	Commercial	Normal or over-development in medium- or high-contrast developer, e.g., D-72 or x-ray developer
Very low	Process	Under-, average, or over-development in high-contrast developer, e.g., x-ray developer

glass to prevent curling of the x-ray film during the relatively long exposures which are recommended below. A rheostat in the circuit to control the intensity of illumination is helpful, and some arrangement should be made for supporting opaque paper or cardboard to exclude light around the edges of roentgenograms of various sizes. The rheostat serves in obtaining as much illumination as is desired through the film, but it must be remembered that a thin roentgenograph will photograph best when transilluminated by weak light, and a dense roentgenograph, with strong light.

The Exposure.—The actual exposure must be made in a semi-darkened room. It is essential that the planes of camera and illuminator be parallel. It is recommended that exposures of all films be made with a high-grade anastigmat lens at an opening of F22 or smaller. Because of the greater depth of focus obtainable at the smaller stop, the copy will be sharp even if the image is slightly out of focus when focussed at the full aperture of the lens. Another advantage is that imperfections in the lens, which usually occur at the circumference, will be excluded, unless they are sufficiently grave to involve the central part. Moreover, since moderately long exposure is necessary with the small stop, there will be a smaller percent-

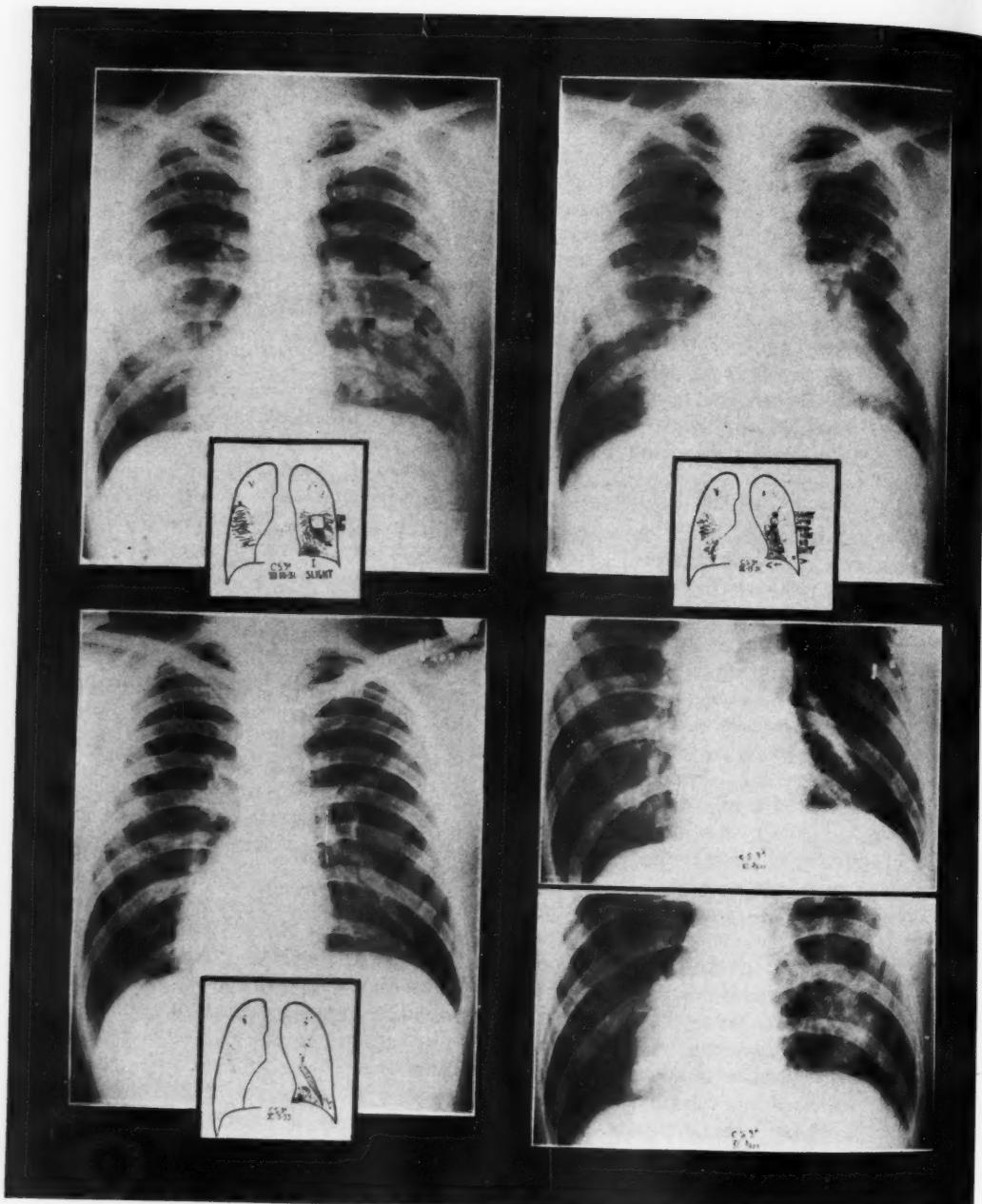


Plate I. Serial views of a case of tuberculosis showing closing of the cavity, with details showing the associated (non-tuberculous) lesion in the lower part of the lung. The arrows were added by the writer to indicate the cavity.³

³ This plate was made for Dr. F. Maurice McPhedran and is reproduced here with his permission.

age of error in calculating and controlling the correct timing of the exposure.

Dodging.—As exposure is calculated for the darker fields, the lighter or less dense fields in some roentgenograms will be much too dense in the positive. Dodging may be required to prevent this disproportionate darkening, and to restore some of the lost detail, by moving a piece of opaque material before the area in the roentgenogram during part of the exposure-time. Experience has shown that dodging should never be continued for more than one-half the total exposure in photographing x-ray films.

The Completed Positive.—The object thus far has been to produce, for contact printing, an intermediate of normal or slightly low contrast. The resulting positive should be of average density, brilliant but soft. The brilliance can be increased by a short treatment with Farmer's reducer, which is excellent for removing the slight fog of excess over-development, and is useful also as a routine procedure. The action of the reducer must be stopped just before shadow detail is attacked, as judged from experience with the solution used.

THE FINAL COPY

Choice of Paper and Developer.—A good final copy can be made from the positive by contact printing on glossy paper of normal contrast (No. 2), or on No. 3 paper if the contrast in the intermediate is slightly too low. Good results can sometimes, but not invariably, be obtained by using the No. 4 grade for an intermediate of still lower contrast. The outcome will always be poor, however, if either extreme, No. 1 or No. 5, must be used because contrast in the positive is much too high or too low.

Paper prints may be developed in D-72 or any developer that produces an image of neutral black, or vigorous blue-black tone. As the developer becomes exhausted, a change in the color of the prints may be observed, and the solution should be discarded when the tone begins to get brownish or muddy.

Dodging.—Dodging should always be used in making the paper print, as film is able to record a much wider range of tone than paper, and some detail may be wiped out completely in the shadows or darker parts of the negative print. These fields can be made less dense in the print, and richer in detail, by placing small pieces of paper on the ground glass of the printer beneath these obscure (light) parts in the positive. For small areas, newspaper with fine print may be used, for larger areas, thin or heavy tissue paper. Again, in reproducing a roentgenogram of low contrast, higher contrast may be sought in the copy, and differentiation of detail in the intermediate positive may have been improved in all places except the light parts, which would print out much too dark in the negative print. Here also, with dodging, some detail will be brought out in the paper print or transparency.

Mounting.—As Dr. McPhedran has found, in serial studies of pulmonary lesions, printing on paper with black instead of the usual white borders will give greater brilliance, and they are also less distracting to the eye in viewing large numbers of prints. (See Plate I.)

Transparencies.—In making film transparencies, the method is substantially the same as for paper prints. The usual printing media are process, translite, and Adlux films. Here, too, in making the intermediate, the same choice is offered in type of film, developer, and length of development, with the chief consideration again the degree of contrast in the roentgenogram, and that desired in the final copy. (See Chart I.) Dodging may be required to bring out obscured detail. Brief treatment with a reducer will remove from the intermediate positive the slight fog caused by over-development, and it may also be used to increase the brilliance of the final copy.

EXPLANATION OF PLATE I

As described in the text, strict attention was paid to securing comparability in density and contrast. The original

roentgenograms reproduced in the plate varied widely in these qualities, having been made with various roentgenographic technics in several x-ray laboratories. That in the upper left was of very low density and contrast; that in the upper right was of low density and moderate contrast; the details in the lower right were made from roentgenograms of average density and high contrast; only that in the lower left was of average density and contrast.

The small diagrams are reductions of tracings of the lesion (as distinct from the blood vessels and other normal lung structures) made directly from the x-ray films by Dr. McPhedran. In reproducing these, process film was used exclusively. The reduced diagrams were fitted into the areas cut out from the reduced (5 X 7

inch) roentgenograms. After all these intermediates (positives of the roentgenograms, negatives of the diagrams) had been affixed by transparent tape to the glass in the printer, they were printed simultaneously on one piece of 11 X 14 inch paper of No. 2 grade.

In printing such a composite, a considerable amount of dodging is necessary to reproduce comparable detail, but there was *no retouching of the positives*, and all flaws in the original roentgenograms were photographed without alteration.

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PEPTIC ULCER: A REVIEW OF 1,033 CASES AND A FOLLOW-UP STUDY OF THE PATIENTS DIAGNOSED BETWEEN 10 AND 20 YEARS AGO¹

By MAURICE F. DWYER, M.D., JOHN M. BLACKFORD, M.D., WILLIAM S. COLE, M.D., and ROBERT H. WILLIAMS, M.D., *Seattle, Washington*

LEVEN years ago (1928) we presented a paper before this Society on "The Interpretation of Gastric Symptoms," based on a clinical and roentgenologic study of 3,000 consecutive patients who came to the clinic on account of stomach trouble (1). This study brought out the fact that only 15 per cent of patients complaining of chronic dyspepsia had organic gastric and duodenal lesions to account for their symptoms, and that in 85 per cent of patients with gastric symptoms the stomach or duodenum was not the primary source of the dyspepsia.

Alvarez (2) made a similar study of 15,000 patients with chronic dyspepsia, examined at the Mayo Clinic, and had practically the same findings. In his series, 3 per cent more patients had organic gastric or duodenal lesions to account for the stomach symptoms than in our series. This comparatively slight difference may be accounted for by the larger number of patients examined, the greater accuracy in the roentgenologic diagnosis, and the fact that, because many patients consult their local physicians during the early stages of stomach disorders, before going elsewhere for a diagnosis, this large clinic sees a greater proportion of patients in the more advanced stages of gastric and duodenal disorders.

We have recently made a detailed study of 1,033 patients who received a diagnosis of peptic ulcer in a private clinic up to Jan. 1, 1939. Every patient in this series was examined by the same clinicians and the same roentgenologist.

While we realize that this is a meeting of radiologists and that you are well versed in the diagnosis of such a common cause of

digestive symptoms as peptic ulcer—which ranks second only to gall-bladder disease as a cause of chronic gastric disturbances—we nevertheless believe that some of the findings resulting from this investigation will be of practical value to you as well as to clinicians. Each year finds radiology and internal medicine more closely associated, and each year finds the radiologist, especially in private practice, called in more frequently as a consultant in regard to the proper procedure to be followed in the diagnosis and treatment of gastric disorders.

This summary is based on a study of 930 duodenal ulcers and 103 gastric ulcers, a ratio of approximately nine to one.

DUODENAL ULCER

Duodenal ulcer is the most frequent intrinsic organic cause of chronic dyspepsia and is a condition encountered most frequently in relatively young people, as 53 per cent of patients place the onset of their gastric disturbances before the age of 30 years. The highest incidence is between the ages of 21 and 30 years, as one-third of our patients began to have stomach trouble during this decade.

The old familiar saying that the symptomatology of duodenal ulcer is so characteristic that the diagnosis can be made over the telephone certainly does not hold true to-day. The present high efficiency of the roentgenologic study of gastro-duodenal pathology will demonstrate duodenal ulcer in about one-fifth of patients with ulcer who present what is anything but a typical ulcer history. This study revealed that only 83 per cent of patients with duodenal ulcer had the so-styled typical history characterized by distress or pain appearing within from two to four hours after meals, food relief, periodicity, epigastric distress, and occasional vomit-

¹ Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11-15, 1939.

ing. In the remaining 17 per cent of uncomplicated cases, the symptomatology was quite indefinite and could easily have been caused by other organic gastro-intestinal lesions or functional or reflex disorders.

The younger the patient at the onset of duodenal ulcer, the more characteristic are the symptoms. There is a gradual decline in the relative frequency of the classical ulcer history as the age of the patients at onset of dyspepsia advances. Patients who stated that they had begun to have digestive disturbances under the age of 40 years presented the typical history in 83.5 per cent of cases in this series, and those whose symptoms began over that age in 68.5 per cent. Every decade after the second shows a decline in the number of patients presenting the so-called classical history of duodenal ulcer.

Patients under the age of 30 who present gastric symptoms suggestive of peptic ulcer are more apt to have an ulcer than are older patients, especially those over 40 years of age, as the causes of reflex manifestations are considerably less frequent in younger patients than among older ones. Neurosis is not common in a patient under 30 years of age, and the reflex disturbances which affect the stomach at this age are due chiefly to appendicitis and rarely to Meckel's diverticulum and internal hernia. Chronic appendicitis, in our experience, has been the cause of gastric symptoms in only

5.5 per cent of patients seeking relief of gastric disturbances. After the age of 40 years, many more intra-abdominal diseases occur, and the reflex disturbances resulting from emotional and functional strains are more frequently encountered—all of which produce symptoms which are difficult for the clinician to differentiate.

Chronic cholecystitis is the most common cause of gastric complaints after the age of 40, and accounts for the stomach symptoms in 21.3 per cent of our patients. Approximately three-fourths (72.7 per cent) of patients suffering from chronic gall-bladder disease seek relief on account of chronic digestive disturbances, and, in over half of these patients, the symptoms have persisted for more than ten years, while only 18.5 per cent give a history of pain simulating that of one or more attacks of "gallstone colic." Chronic cholecystitis without stones frequently presents symptoms simulating those of duodenal ulcer. It is not uncommon for the patient to give a history of hunger pain appearing two or three hours after eating and brought under control by food and alkalies, the only variation from the ulcer picture being that in cholecystitis the exacerbations are not of such long duration and occur with less regularity. Even gross hemorrhage is occasionally found in patients with chronic cholecystitis.

It becomes apparent, therefore, that careful roentgenologic examination is the

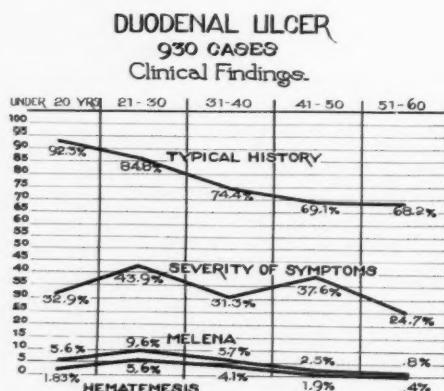


Fig. 1.

CLINICAL AND VITAL STATISTICS OF MASSIVE HEMORRHAGE

UNDER 45 YRS.		OVER 45 YRS.
MASSIVE HEMORRHAGE 57 private cases.	29	28
DEATHS FROM MASSIVE HEMORRHAGE Seattle Vital Statistics (1938-39)	3 1 gastrojejunal ulcer 2 post-operative complications (not due to hemorrhage)	6 deaths due to hemorrhage (2 operated after failure of prolonged medical treatment.) 5 of 6 deaths followed post-hemorrhage
DEATHS FROM MASSIVE HEMORRHAGE due to peptic ulcer 51	3 1 gastrojejunal ulcer	52 3 gastrojejunal ulcers

Fig. 2.

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most important factor in diagnosing or excluding duodenal ulcer.

GASTRIC ULCER

Gastric ulcers probably have the same etiology as duodenal ulcers but exhibit considerable difference clinically in their symptomatology, diagnosis, prognosis, and treatment.

A summary of the histories of the 109 patients in this series with gastric ulcer shows that, as compared with the duodenal lesion, gastric ulcer is found in relatively older persons, for only 29 per cent of the patients placed the onset of their gastric disturbances before the age of 30 years, whereas 53 per cent of patients with duodenal ulcer claimed the onset of their trouble before this age.

The symptomatology of gastric ulcer often presents atypical and irregular disturbances, and these tend to be more severe than those associated with duodenal ulcer. Two-thirds (66.2 per cent) of our patients with gastric ulcer complained of severe gastric pain, as compared with only one-third (35.9 per cent) of the patients with duodenal ulcer. Hematemesis was found twice as frequently (28.1 per cent) in gastric ulcer as in duodenal ulcer (14.2 per cent). Melena of varying degree occurred in one-third of the gastric ulcer cases (33.9 per cent) and in one-fourth (25.3 per cent) of the duodenal ulcer cases.

The roentgenologic examination of the stomach and duodenum is familiar to all of you, and it suffices to say that careful examination and proper interpretation of the appearance of stomach and duodenum as to marginal deformities, demonstration of the niche whenever possible, and study of the rugae and mucosal patterns will accurately diagnose approximately 20 per cent more cases of peptic ulcer than can be determined by clinical methods alone. A negative roentgenologic diagnosis, except after recent hemorrhage, is seldom in error. In this series of 930 duodenal ulcers, the clinical and the roentgenologic diagnosis agreed in 92.9 per cent of cases.

In the 7.1 per cent of cases in which there was disagreement, 33 per cent were in patients examined from four to six weeks after massive hemorrhage.

HEMORRHAGE

Hemorrhage is one of the major complications of peptic ulcer, and by far the most common cause of intestinal hemorrhage is duodenal ulcer. We recently made a detailed study of massive hemorrhage from peptic ulcer, based on personal experience in a private clinic and from the Vital Statistics of the City of Seattle. Although we realize that the roentgenologist seldom sees a patient with gross bleeding or massive intestinal hemorrhage until a month or more after the cessation of bleeding and that the roentgenologic investigation is of little help in the location of a pathologic condition productive of active gastrorrhagia, nevertheless the roentgenologist is being called upon with increasing frequency to act as a consultant in determining the proper method of dealing with the complications of peptic ulcer. Hence a summary of our findings is presented in the belief that it will be of value to the roentgenologist as well as to the clinician.

Tabulation of our histories in 1,076 cases of peptic ulcer seen in this clinic through March, 1939,² showed that hemorrhage was recorded in 208, or 19 per cent, of patients with peptic ulcer and that the great majority of deaths from hemorrhage occur in older patients. Active hemorrhage has caused 113 patients to consult the clinic. Half of these patients had melena or hematemesis in moderate amount, without producing serious symptoms, which cases were classed as *gross hemorrhage*. The remaining half, or 57 patients, were suffering from serious loss of blood with alarming symptoms of exsanguination, and these cases have been classified as *massive hemorrhage*. The diagnosis of mas-

² The study of hemorrhage included the 1,033 patients seen previous to Jan. 1, 1939, and was carried on over patients seen in the following three months.

sive hemorrhage was made on those patients who presented evidence of large loss of blood, with pallor, weakness, sweating, and prostration.

The histories of the 57 patients with massive hemorrhage showed that more than half complained of relatively mild gastric symptoms. Neither chronicity, severity, age, nor sex gives a clue as to which ulcers are likely to bleed. At the time of massive hemorrhage, only one-third of the patients were having severe symptoms due to ulcer. Two-thirds of the massive hemorrhages occurred during relatively quiescent periods, and five of the six deaths occurred during the patient's first hemorrhage.

There is a remarkable contrast between the incidence by age of massive hemorrhage as compared with first hemorrhage from peptic ulcer. Massive hemorrhage occurs with equal frequency below and above the age of 45, yet vital statistics show that nearly all fatalities occur in the older group. The Bureau of Vital Statistics of the City of Seattle recorded 216 deaths from peptic ulcer, with 93 autopsies, in three years. The deaths from massive hemorrhage were 55, with 24 autopsies. The youngest patient was 39 years of age, the next youngest 44; all others were more than 45 years old.

The rarity of fatal hemorrhage from peptic ulcer before the age of 45 is manifest by the fact that only two out of 55 fatalities

from chronic peptic ulcer hemorrhage occurred in patients under this age, or 4 per cent of all deaths from this cause. Fatal hemorrhage from peptic ulcer in young people is so rare that we are probably never justified in advocating surgery on such a case as an emergency measure.

The percentage of fatalities from a severely bleeding ulcer after the age of 45 years presents a different problem. Of 51 cases of fatal hemorrhage from peptic ulcer, 49 were in patients above this age. Owing to the fact that fatal bleeding occurs in approximately 30 per cent of serious hemorrhages in older persons, the surgeon is certainly justified in attempting to stop such hemorrhages by operative measures.

The clinician needs prompt surgical consultation in the presence of serious hemorrhage when the patient is in the older group, as 96 per cent of all deaths from hemorrhage occur after the age of 45, whereas personal experience and vital statistics show that emergency surgery for bleeding ulcer is not justified on patients under 45 years of age. No patient in our series under the age of 45 died except as an immediate or late result of surgical interference. Early emergency surgery for massive hemorrhage from ulcer in patients over this age should save many lives.

ACUTE PERFORATION

Our records show that, of 82 patients with acute perforation of peptic ulcer who

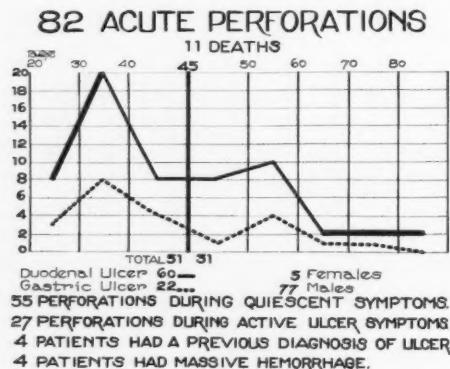


Fig. 3.

DUODENAL ULCER 10-25 YEAR FOLLOW-UP (AVERAGE 14 YEARS)

141 CASES

RELIEF.	Medical 77 CASES	Surgical 64 CASES
Satisfactory	65%	86%
Un-satisfactory	35%	14%

Fig. 4.

were operated on in the Virginia Mason Hospital, in only four instances was massive hemorrhage associated with the perforation and all four patients survived the operation. Most perforations take place in the earlier stages of the disease. Twice as many acute perforations of peptic ulcer occurred between the ages of 30 and 40 years as in any other decade. One-third of the 930 patients with duodenal ulcer in this series gave the onset of their gastric disturbances as between 21 and 30 years of age, and 33 per cent of perforations of duodenal ulcer occurred between the ages of 31 and 40 years. Sixty-one per cent of the total number of perforations occurred under 45 years of age.

Severity of symptoms is no guide to the clinician as to which ulcers may perforate, as two-thirds of these ulcers perforated during quiescent periods and only four patients knew that they had an ulcer before perforation occurred.

FOLLOW-UP STUDY

In order to obtain some information as to the progress of patients with duodenal ulcer, we recently sent out questionnaires to 238 patients who had been treated for ulcer from 10 to 20 years ago. We have been unable to find in the literature a similar study of medically and surgically treated patients followed after ten or more years.

Smithies (3), in 1925, reported a two- to ten-year follow-up of 470 cases of duodenal ulcer that had been treated medically, with satisfactory results in 77 per cent of the group. In 1929, Blackford and Bowers (4)—including Mason—reported the results of a two- to ten-year follow-up study of 86 cases of peptic ulcer treated medically, with 58.1 per cent satisfactory results; and 103 ulcer cases treated surgically, with 72.9 per cent good results. Balfour (5), in 1927, reported the results of the surgical treatment of 100 well selected cases of duodenal ulcer in physicians. Posterior gastro-enterostomy was performed, with complete relief of symptoms

in 87 per cent of the cases, at an average of eight and one-half years following the operation.

When we sent out the questionnaires we realized that patients are often confused in making out such reports, and, therefore, we tried insofar as possible to ask only a few general questions, stated in as simple form as possible.

These persons were asked whether or not they had obtained complete relief from either surgical or medical treatment for their ulcers, and, if not, whether or not they considered themselves 75 per cent, 50 per cent, or 25 per cent benefited, or not benefited at all from their treatment.

Response to the questionnaire was received from 141 patients, 77 of whom had received medical and 64 surgical treatment for their ulcers. The average time which had elapsed since the institution of treatment had been 14 years, in both the surgical and the medical group.

A tabulation of the results in the 77 patients who had received medical treatment for their duodenal ulcers more than ten years ago showed that 65 per cent considered themselves as having obtained 75 per cent or more relief of their gastric symptoms. Approximately one-third (35 per cent) of the medically treated patients stated that they had obtained only 50 per cent or less relief of the symptoms, and one-half (56 per cent) of the patients with unsatisfactory results later received surgical treatment. Pyloric obstruction developed in 6 per cent of the medically treated cases at an average of ten years.

A summary of results of the 64 patients treated surgically revealed that after an average of 14 years from the time of operation 86 per cent considered that they had received 75 per cent or more relief from their operation. Posterior gastro-enterostomy was done on 52 of these patients, and satisfactory results were obtained in 90 per cent; pyloric obstruction had been the indication for operation in only six of these cases. Excision of the ulcer was done in the remaining 12 patients, and,

after ten years, only one-third stated that they considered the operation a success.

Conservative surgical treatment of properly selected cases has, for many years, given satisfactory results in from 85 to 90 per cent of patients operated upon for peptic ulcer. Of all these patients treated surgically ten or more years ago, none received the present-day radical treatment of gastric resection for duodenal ulcer, and sufficient time has not elapsed to compare the symptomatic relief of the patients treated more radically with those treated by posterior gastro-enterostomy and simple excision.

SUMMARY

1. Duodenal ulcer is the most frequent intrinsic organic cause of chronic dyspepsia, second only to gall-bladder disease as a cause of gastric symptoms. It is a condition encountered most frequently in relatively young individuals, of whom one-third report the onset of symptoms as having occurred between the ages of 21 and 30 years.

2. The present high efficiency of the roentgenologic diagnosis will demonstrate duodenal ulcer in approximately 17 per cent of patients who present anything but a typical ulcer history.

3. The younger the patient at the onset of duodenal ulcer, the more characteristic the history.

4. The symptomatology of gastric ulcer often presents atypical and irregular disturbances and tends to be more severe than that associated with duodenal ulcer.

5. Hemorrhage was recorded in 208, or 19 per cent, of the patients in this series. Active hemorrhage was the cause of 113 of these patients seeking relief.

6. Massive hemorrhage is found more frequently before 45 years of age than after, but vital statistics show that only 4 per cent of all deaths from massive hemorrhage from peptic ulcer occur under the age of 45.

7. Early emergency surgery for massive hemorrhage from ulcer in patients over 45 years of age should save many lives.

8. A study of 141 patients treated from 10 to 20 years ago revealed that 65 per cent of the medically treated and 86 per cent of the surgically treated patients considered that they had obtained satisfactory relief from the gastric disturbances.

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DISCUSSION

WALTER D. HANKINS, M.D. (Johnson City, Tenn.): This paper has been of great interest to me because it has taken up the clinical rather than the roentgenologic aspects of this disease, which are more or less familiar to all of us. This is particularly important, I feel, to the radiologist in the small town where the patient is referred by the general practitioner and his advice as to the management of these cases, particularly as to whether they should be operated on, is often sought.

So, although we are not practising internal medicine, we should be more or less in a position to offer help to the clinician who refers cases to us, rather than remain simply x-ray men or film readers.

The importance of x-ray diagnosis in cases of duodenal ulcer is brought out in this paper, and we realize that this condition would be missed in 20 per cent of cases unless they were x-rayed.

The importance of the age group in cases of hemorrhage is a highly essential point. I never have seen this analyzed as to the ages of the patients as it has been in this paper, in which we see that it is an important factor when we are consulted as to

whether or not a patient with a massive hemorrhage should be operated upon.

Dr. Dwyer made one point to which I might take exception: that is, that the young patient should not be operated upon. In young individuals who have repeated massive hemorrhages, it would seem to me better to go ahead and operate upon those patients, since the prognosis becomes worse as they grow older.

In other words, in the case of a patient 30 or 35 years old, with repeated massive hemorrhages, I think operation would be indicated rather than wait until he is 45 or 50 years of age and then operate. We feel that in cases of definite obstruction—say a gastric residue of 50 per cent or more—such patients are best taken care of if they are gotten into condition with blood transfusions, fluids, etc., and operated upon immediately. We have seen quite poor results from medical treatment in obstructive ulcers, and feel that, eventually, most such cases will come to operation years later and thus valuable time will have been lost unless immediate operation is done.

There is one other point in the follow-up of Dr. Dwyer's cases. We do not know how well these patients have followed medical treatment. A patient leaves the doctor; we do not see him for several years and although we send him questionnaires, we do not know whether or not he has followed the medical treatment faithfully, nor do we know what kind of medical treatment he may have followed.

Also, in the surgically followed cases, I think it is well to consider whether they

not only have had surgery but whether, in addition, they have had medical treatment along with the surgery.

I was certainly interested in this paper. I think it is a subject to be carefully considered because often the radiologist is consulted by the general practitioner, who, after all, does not see as many cases of this type as the radiologist.

MAURICE F. DWYER, M.D. (*closing*): I have nothing in particular to add. I think Dr. Hankins is perfectly right in advocating surgery in patients under 45 years of age who have had repeated hemorrhages from duodenal ulcer.

Regarding the medical follow-up and especially with reference to the question of how well these patients have adhered to their diet and medication, I will not go into that, but will state that we made a comparative study of patients with duodenal ulcer treated by hospitalization and ambulatory methods and the end-results were practically the same.

There is one point in this paper which we, the writers, wish to emphasize, namely, that massive hemorrhage from peptic ulcer is found more frequently in persons under 45 years of age yet only 4 per cent of all deaths from massive hemorrhage occur before that age. These cases, we believe, should be treated conservatively; on the other hand, since fatal bleeding occurs in approximately 30 per cent of cases of serious hemorrhage in older individuals, the surgeon is certainly justified in advocating early operation in the latter cases.

SLIGHT ENLARGEMENT OF THE HEAD OF THE PANCREAS: ASSOCIATED PATHOLOGIC CHANGES IN THE DUODENUM¹

REPORT OF SEVEN CASES

By MAURICE FELDMAN, M.D., Baltimore, Maryland

RECENTLY, the radiologic demonstration of slight enlargement of the head of the pancreas has been brought to our attention (1, 2, 3). Previously, the radiologic diagnosis of pancreatic disease was made only in late instances, when the excessive enlargement of the head of the pancreas had produced signs of pressure against the adjacent viscera. Because of the position of the pancreas, especially its relation to the concave aspect of the duodenum, and the greater curvature of the pylorus, pressure defects are usually observed when the tumor mass has attained a large size. Since the majority of pancreatic lesions involve the head, and its close relationship with the ampullary portion of the duodenum, recent roentgenologic advances are now more likely to disclose some abnormality in this segment at an earlier period than has heretofore been possible.

¹ Accepted for publication in October, 1939.

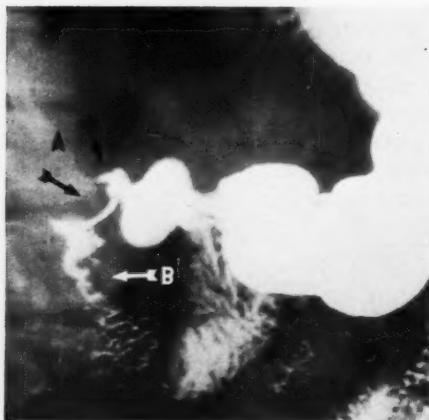


Fig. 1. Case 1. A cicatricial duodenal ulceration is shown at arrow A. The ampullary portion of the duodenum demonstrates a pressure deformity, with an inverted figure 3 defect at arrow B.

The roentgenologic changes in the mu-roentgen picture in three necropsy cases. Recently we have observed two cases which clearly demonstrated the characteristic type of pressure-filling defect in the ampullary portion of the duodenum produced by slight enlargement of the head of the pancreas.

The radiologic criteria for the diagnosis of minimal enlargement of the head of the pancreas are as follows: (1) an inverted figure 3 pressure-filling defect in the ampullary portion of the duodenum; (2) two small depressions of smooth contour, well defined, produced by pressure of the enlarged head, with a small nipple-like projection between the two depressions, which represents the papilla; (3) distortion of Kerkring's folds; (4) displacement of surrounding mucosa; piling up of mucosal folds; (5) changes in contour of the ampullary portion of the duodenum.

The defective ampullary segment of the duodenum is constantly visible in serial cosal configuration and contour of the ampullary portion of the duodenum offers a new field for the diagnosis of intrinsic and extrinsic pathology affecting this segment of the intestine. Scant attention has been directed to the importance of the minute examination of the ampullary portion of the duodenum. It must be emphasized that other changes might be present as an accompanying phenomenon which cannot at this time be interpreted. A study of the early changes of the mucosa and configuration of the ampullary portion of the duodenum merits, therefore, considerable study. Frostberg, in 1938, called attention to a new roentgen sign, produced by slight enlargement of the head of the pancreas, and demonstrated a characteristic

roentgenograms, although we find that it may be demonstrated in only a few films of a large series. Its demonstration depends, to some extent, upon the angle at which the roentgenogram is made. The constancy of the defect also depends upon the amount of pressure and extent of filling of the duodenum. The sign is best observed on films made in the prone position, but, at times, is also observed on those made in

the oblique position. One might point out the fact that it is often necessary to take a large number of small films of the duodenal area in different positions in order to demonstrate the characteristic features of this condition.

Heretofore the roentgenologists' technic and experience did not permit an early diagnosis of lesions affecting the ampullary portion of the duodenum. How-

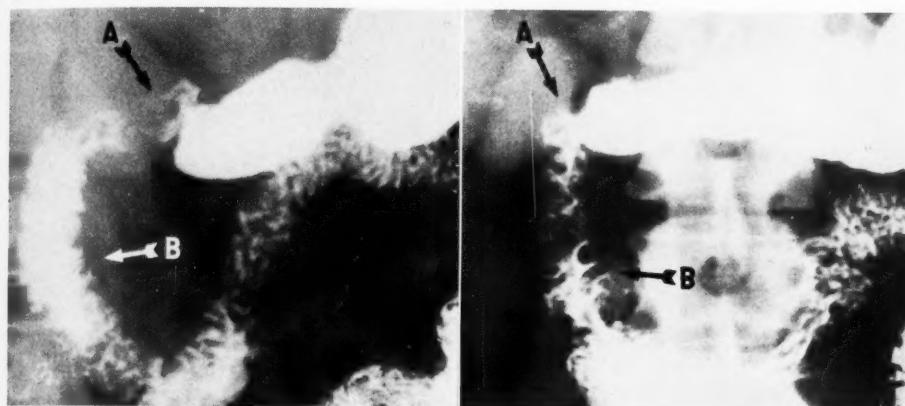


Fig. 2. Case 2 (left). An ulcer filling defect is shown in the duodenal bulb at arrow A. Note also the contour irregularity in region of ampulla at arrow B.

Fig. 2. Case 2 (right). A deformed diminutive duodenal bulb is shown at arrow A. An inverted figure 3 pressure defect is illustrated at arrow B.



Fig. 3. Case 4 (left). A small rounded smooth defect is demonstrated at arrow A, representing a small polyp. Mucosal contour changes demonstrated in the ampullary portion of duodenum at arrow B.

Fig. 3. Case 4 (center). The neoplastic defect is shown at A; the characteristic pressure defect is shown at arrow B, in the ampullary portion of duodenum.

Fig. 3. Case 4 (right). An inverted figure 3 pressure defect is illustrated at the arrow, due to pressure from the head of the pancreas. Note the piling up and thickening of the mucosa in this area.

ever, slight changes of the direction, shape, and contour of the mucosal markings may be shown by the x-ray which offers a means of early diagnosis of disease of the head of the pancreas. Meticulous examination, paying special attention to the

ampullary portion of the duodenum, will often yield findings of inestimable diagnostic import.

The early roentgen diagnosis of disease of the head of the pancreas may be further improved by crystallizing the clinical and

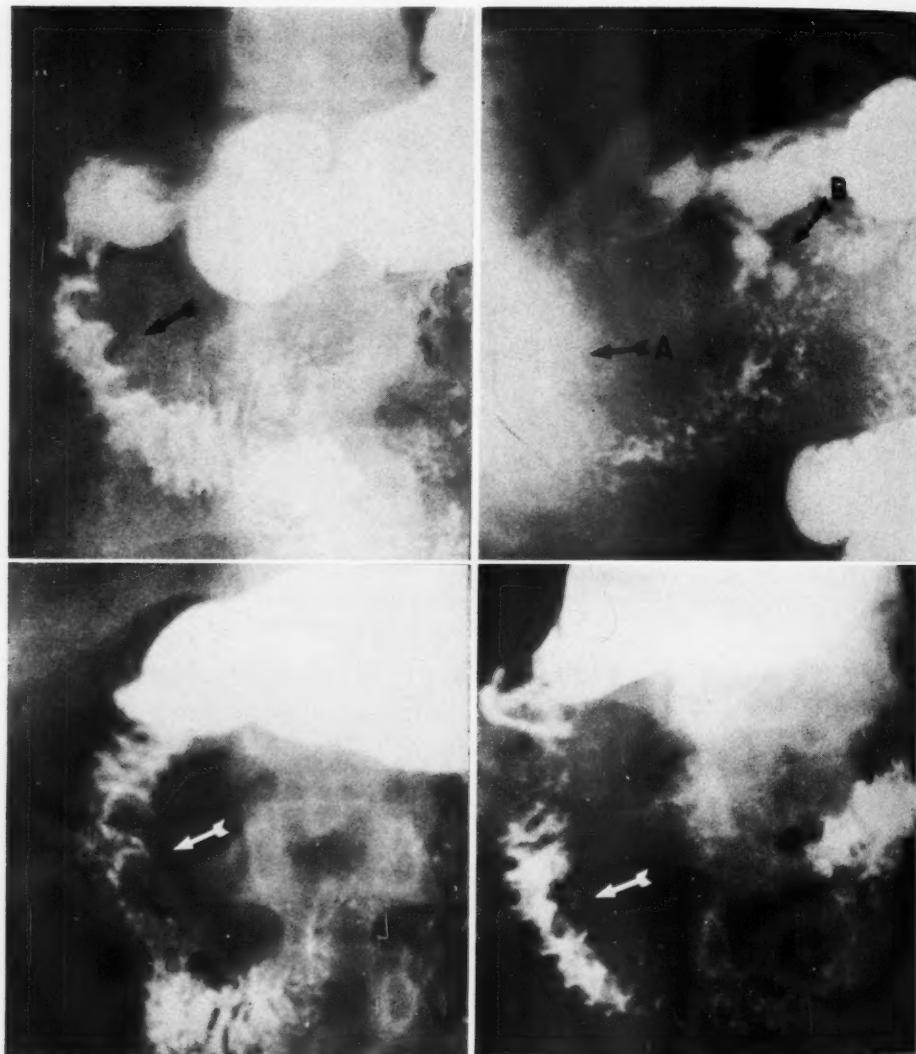


Fig. 4. Case 5 (upper left). An inverted figure 3 defect is shown in the ampullary portion of duodenum.
Fig. 4. Case 5 (upper right). An irritable, irregular descending duodenum is shown at arrow A. Two small diverticula are demonstrated in the ascending duodenum at arrow B.

Fig. 4. Case 6 (lower left). A large inverted figure 3 pressure defect of the ampullary portion of the duodenum is shown at the arrow.

Fig. 4. Case 3 (lower right). An inverted figure 3 pressure defect is illustrated at the arrow. Note the compression of the mucosa in this area. Also note the contour change on the outer aspect of the duodenum in the region of ampulla.

roentgenologic picture in a large series of cases. The clinical and roentgenologic data in this series of cases were deemed adequate to sustain the diagnosis of some abnormality of the pancreas.

The association of enlargement of the head of the pancreas with coexisting duodenal disease has not been roentgenologically recognized. There seems to be little, if any, information on this subject in the current literature. This paper is primarily concerned with a report of seven cases presenting evidence of the characteristic inverted figure 3 pressure-filling defect in the ampullary portion of the duodenum, due to pressure of the head of the pancreas, with other associated duodenal disease. This subject is, therefore, of sufficient interest to warrant a brief report.

All of the seven cases were males. The ages ranged from 29 to 69 years. In four of the seven cases, a gall-bladder visualization test had been made and a normal, functioning gall bladder, without stones, had been found. Of particular interest in this small series of cases is the association

of other duodenal abnormalities. Of the seven cases, five revealed distinct evidence of duodenal pathology; two of these presented a duodenal ulceration of the bulb; one a duodenal ulceration with filling of the ampulla of Vater; one a duodenal diverticulum, and, in the other, a duodenal polyp.

A brief history of the seven cases is presented, two of which have previously been reported (2).

Case 1. Male, aged 46 years, for many years complained of gas pains in upper abdomen, which were relieved by food and became worse with hunger. He was wakened during the night by abdominal pains. Several months ago he had a gastric hemorrhage, with black stools. Eight years previously his appendix had been removed without relief of symptoms. Roentgenologic examination of the gastro-intestinal tract showed a markedly deformed duodenal bulb with an ulcer niche filling defect. At the juncture with the second portion of the duodenum there was a cicatricial annular defect. The ampullary portion of the duodenum revealed an inverted

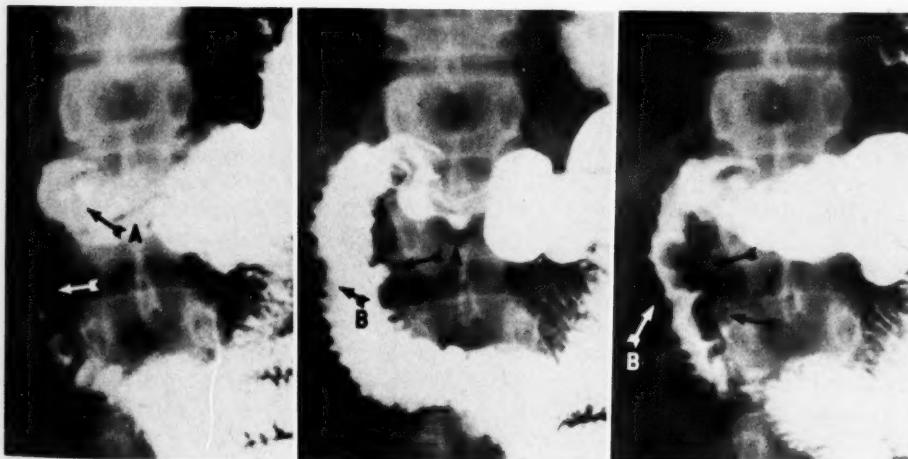


Fig. 5. Case 7 (left). Two ulcer niche defects are shown in the duodenal bulb at arrow A. An irritable descending duodenum is shown at arrow B.

Fig. 5. Case 7 (center). A projection is demonstrated at arrow A, representing a filled ampulla of Vater. Note the smooth-cut contour surrounding the ampulla at A. Contour mucosal change on the outer aspect of the duodenum is shown at arrow B.

Fig. 5. Case 7 (right). A large inverted figure 3 pressure defect is demonstrated in the ampullary portion of the duodenum at arrows A. Note the compression of the mucosa as evidenced by the thickening of the margins of the inverted 3. B illustrates the contour and mucosal changes on the outer aspect of the descending duodenum in the ampullary region.

figure 3 pressure defect, with mucosal changes characteristic of pressure from swelling of the head of the pancreas. A cholecystographic study yielded a normal, functioning gall bladder without stones.

Case 2. Male, aged 57 years, complained of vague digestive disturbances, gas, distention, bloating of abdomen, without pains. Examination of stools revealed evidence of a pancreatic disturbance and also of occult blood. A gastro-intestinal x-ray examination showed a rapidly emptying stomach, with a deformity of the duodenal bulb, due to an ulceration. The descending portion of the duodenum in the ampullary segment showed an inverted figure 3 pressure-filling defect due to slight enlargement of the head of the pancreas. The remaining small intestine was normal; the colon was markedly irritable. A gall-bladder study revealed a normal, functioning gall bladder without stones.

Case 3. Male, aged 54 years, complained of epigastric pains of six months' duration, loss of weight, abdominal distention, belching, and constipation. A gastro-intestinal x-ray examination revealed a prepyloric narrowing with mucosal changes suggestive of a gastritis. The ampullary portion of the duodenum showed an inverted figure 3 pressure defect, due to swelling of the head of the pancreas. The colon showed a mucous colitis stringing, due to an irritable bowel. A cholecystographic study revealed a normal, functioning gall bladder without stones.

Case 4. Male, aged 69 years, complained of epigastric burning of a few months' duration. He had no pains. Stool examination revealed evidence of occult blood. Roentgen examination of the gastro-intestinal tract showed a normally emptying stomach. The pylorus appeared to be normal; the duodenal bulb filled well, showing no evidence of ulceration. A small polyp type of defect was observed in the upper portion of the descending duodenum. In the ampullary portion of the duodenum there was a pressure defect with changes in the mucosal pattern due to pressure from a

slight swelling of the head of the pancreas. The colon revealed evidence of a diverticulosis.

Case 5. Male, aged 48 years, complained of epigastric pains and vomiting of six weeks' duration. Roentgen examination of the gastro-intestinal tract showed a pressure defect in the ampullary portion of the duodenum, with some compression of the mucosal folds, producing an inverted figure 3 type of filling defect. There was also evidence of two duodenal diverticula and adhesions in the right upper quadrant. An irritable colon with mucous colitis stringing was also observed. A cholecystographic study revealed a normal, functioning gall bladder without stones.

Case 6. Male, aged 29 years, suffered with epigastric pains which occurred about two hours after eating. Roentgen examination of the gastro-intestinal tract showed a normal stomach and pylorus. The duodenal bulb filled well, appeared to be normal under compression, and showed no evidence of ulceration. The ampullary portion of the duodenum revealed an inverted figure 3 type defect with characteristic mucosal changes which indicated the presence of pressure from swelling of the head of the pancreas. There was also evidence of a spastic, irritable colon.

Case 7. Male, aged 31 years, with acute onset of a few days' duration, complained of an attack of pain on the right side, which did not radiate. He was nauseated but did not vomit. His appetite was poor and bowels were constipated. There was no gross hemorrhage and no previous operative procedures. Roentgen examination of the gastro-intestinal tract revealed a spastic pylorus; two small ulcer niche defects were seen at the pyloroduodenal junction. The base of the duodenal bulb showed a crescent-shaped pressure defect. A small projection was noted on the lesser curvature side of the duodenum in the ampullary portion, suggesting filling of the ampulla of Vater. In this area an inverted figure 3 pressure defect was demon-

strated, which presented a characteristic picture of pressure from the head of the pancreas. The remaining gastro-intestinal tract was negative.

SUMMARY

Seven cases of slight enlargement of the head of the pancreas are presented, with roentgenologic criteria. Of special interest in this communication is the association of other duodenal disease coexistent with enlargement of the head of the pancreas. Of the seven cases of enlargement of the head of the pancreas which presented signs of a characteristic pressure,

inverted figure 3 defect, five revealed evidence of other coexisting duodenal abnormalities. Of these, two revealed a duodenal ulceration, one a duodenal ulceration with filling of the ampulla of Vater, one with a duodenal polyp, and one with a duodenal diverticulum.

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CASE REPORTS

HERNIATION OF THE SPLENIC FLEXURE OF THE COLON BEHIND THE SPLEEN¹

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Internal abdominal hernia is an uncommon condition, the nature of which often is not recognized before surgical intervention. This subject has been reviewed by Moynihan and Dobson (6), in 1906, by Short (7), in 1925, and recently by Hansmann and Morton (3). The last mentioned authors have tabulated the articles on internal hernia appearing since Moynihan and Dobson's summary. The total number of recorded cases as listed by them is 467. The abdominal fossae commonly involved and the relative frequency of herniation at the various sites may be obtained from Table I.

TABLE I

Left paraduodenal	138
Transverse mesocolon	60
Right paraduodenal	47
Mesenteric	38
Foramen of Winslow	37
Pericecal	31
Intersigmoid	28
Broad ligament	18
Ileo-appendicular	16
Ileocolic	14
Prevesical	13
Inferior duodenal	5
Great omentum	5
Ascending mesocolon	4
Miscellaneous	13
Total	467

According to this compilation, herniation into the left paraduodenal fossa is the most common. For some locations only a few cases have been reported.

The presence of an intra-abdominal hernia may produce a confusing picture on roentgenologic examination of the intestinal tract because of the anomalous position of the intestinal viscera. Less difficulty is encountered when only the small intestine is involved. The barium-filled loops of small bowel tend to be collected in a compact mass and the actual entrance and exit of the loops of bowel into the

hernial sac may be demonstrated (2). When obstruction of severe grade is present, the diagnostic difficulties are increased (3).

The following case is reported because it represents a type of internal hernia which has not been previously described, according to a search of the available literature, and because the roentgen diagnostic signs appear to be quite pathognomonic.

Case Report (X-ray No. A006374).—The patient, white male, aged 51 years, was admitted to the State of Wisconsin General Hospital on Dec. 6, 1938. He stated that for 25 years he had been unable to lie on his left side without suffering sharp, cramplike pains in the left side of the abdomen. This had increased in severity during the past six years. The pain would be relieved by lying on the right side. He had been more or less constipated as long as he could remember and had used cathartics for the past 30 years. General physical examination gave essentially negative results. Routine laboratory studies were within normal limits. Roentgen examination of the gastrointestinal tract following a barium meal revealed a gas-distended loop of bowel, the splenic flexure of the colon, occupying the left upper quadrant of the abdomen (Fig. 1). An ovoid soft-tissue mass which was considered to be the spleen could be seen lying just to the left of the upper lumbar spine, the outer border being visualized through the gas shadow of the colon, and obviously displaced considerably from its normal location. A separate shadow representing the left kidney could be seen just below the displaced spleen. There was a considerable amount of impacted feces in the ascending portion of the colon and a film made three hours after the meal had been given showed some dilatation of coils of lower jejunum and ileum in the lower abdomen. On barium enema examination, the colon filled readily to the cecum but there was a definite constriction of the lumen of the transverse portion in its distal third with a ballooned-out splenic flexure above (Fig. 2). A diagnosis was made of herniation of the splenic flexure between the spleen and the lateral abdominal wall. Operation was done on Dec. 17, 1938. The transverse and ascending portions of the colon were found to be dilated and the splenic flexure was herniated around and behind the splenic mesentery. Since this could not be freed readily, an anastomosis between the transverse colon and the first portion of the sigmoid was done. The post-operative course was uneventful and the patient was discharged on Dec. 31.

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COMMENT

This type of hernia evidently is uncommon, since no reference to it could be found in the literature. The roentgen appearances, however, left little doubt as to the nature of the condition. The unusual location of the spleen coupled with the persistently distended loop of the splenic flexure and the evidence of slight constriction at the point where it had herniated seemed to point definitely to an internal hernia. In view of the patient's history it seems probable that the condition had been present for many years, at least 25, and the possibility that the lesion was present at birth cannot be excluded. Normally, a gas-filled splenic flexure often is found high up in the left upper quadrant of the abdomen beneath the diaphragm. In these instances the flexure lies anterior to the spleen and observation in the lateral view will readily demonstrate this fact. In reviewing the peritoneal relationships of the spleen it is seen that this organ is invested with peritoneum except at the hilum. A potential space, the left subphrenic fossa, exists between the left dome of the diaphragm, the left lobe of the liver, the stomach and the spleen (4). Similarly, a potential space is present behind and lateral to the spleen. In our case, the splenic flexure had slipped into this space and for some reason had become adherent as evi-

denced by the difficulty in freeing it at operation; or else the colon had developed in this anomalous location similar to those cases in which the transverse colon is found in retro-position (1, 5). It seems strange that such a mishap does not occur more often. A probable explanation is that it does, but because of the free entrance and exit of the loop of bowel no obstruction is produced and the displacement is only of a temporary nature. A somewhat similar counterpart is seen rather frequently on the right side of the abdomen where the hepatic flexure prolapses between the liver and the right dome of the diaphragm. We have seen this intermittent type of prolapse in a number of instances without any evidence of obstruction and it has received recognition in the literature. Since the case we are reporting was observed, we have been able to demonstrate, in one instance, a retroposition of the splenic flexure behind the spleen but without evidence of obstruction. Whether more frequent observation of the abdomen in the lateral view would reveal this to be a relatively common occurrence, we are unable to state.

SUMMARY

1. A case of herniation of the splenic flexure behind the spleen is reported.



Fig. 1.

Fig. 1. Roentgenogram made three hours after a barium meal. A gas-distended loop of colon, the splenic flexure, occupies the left upper quadrant. The spleen is clearly visualized through the gas and is seen to be displaced medially and inferiorly.

Fig. 2. Roentgenogram of the colon after barium enema, showing narrowing of the lumen in the distal part of the transverse segment at the point of herniation.

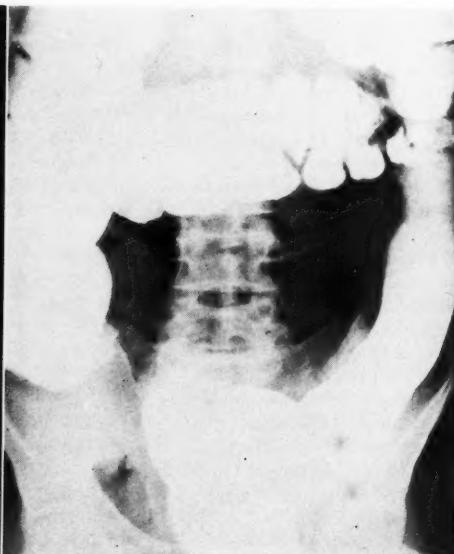


Fig. 2.

2. Brief mention of the peritoneal relationships of the spleen is made, with consideration of the etiology of this type of hernia.

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PERSIMMON PHYTOBEZOAR MISTAKEN FOR GASTRIC CANCER¹

By T. H. McCARLEY, M.D., and EDWARD D. GREENBERGER, M.D., McAlester, Oklahoma

Persimmon phytobezoar is not a rare finding in the Southern States. An excellent paper on this subject was presented by Dr. Richard White,² in which he reviewed the literature and presented three of his own cases.

The association of a gastric ulcer in the presence of a phytobezoar is unusual, as is the association of a phytobezoar in a carcinomatous stomach. When the phytobezoar produces such changes in the stomach that it simulates roentgenologically advanced cancer of the stomach and is diagnosed as such, the case is worth adding to the literature on phytobezoars.

Case Report.—This 38-year-old trusty prisoner entered the McAlester Oklahoma State Penitentiary Hospital in July, 1939, with a history of profuse hemoptysis and sharp gastric pain of ten days' duration. He gave a history of irregular gastric distress for several months prior to the onset of gastric bleeding. The rest of his history obtained on admission was negative.

On admission to the hospital, the patient was

¹ Accepted for publication in December, 1939.

² White, Richard J.: Persimmon Phytobezoar: Report of Three Cases. *Southern Med. Jour.*, **31**, 750-756, July, 1938.

extremely weak, showed evidence of marked loss of blood and weight. The hemoglobin was 40 per cent. Palpation of the stomach revealed a hard mass in the epigastrium, along the left costal arch. The patient was given two blood transfusions, to which he responded remarkably. X-ray studies were done a week after admission to the hospital.

As soon as the barium meal entered the pars media of the stomach, its course was deviated to the left and right sides of the stomach by a large fixed mass. The rugae in the pars media and pylorus were distorted. The lesser curvature of the pars media was markedly irregular and distorted in outline. The finger-like projection seen in this irregular area was interpreted as being due to the broken outline in the lesser curvature of the stomach. There was no involvement of the greater curvature of the stomach or the region just proximal to the pyloric ring. A roentgen diagnosis of a large polypoid-type carcinoma of the stomach was made from the above findings.

The patient was placed on morphine and other sedatives in view of the fatal prognosis. Instead of continuing to lose ground, the patient improved steadily and rapidly. He gained weight and was able to be ambulatory. His hemoglobin reached 70 per cent in seven weeks.

After two months of such clinical observation, the patient was anxiously re-examined roentgenologically.

The hard mass was still present in the lower half of the stomach, but it seemed slightly smaller and now was movable. There were good peristaltic waves over the entire greater curvature of the stomach. No irregularities whatever were present on the greater curvature in the region of the tumor mass. On the lesser curvature, there was a large penetrating ulcer about 3 cm. in diameter. Peristalsis was absent on each side of the ulcer. The marked irregularity of the lesser curvature of the stomach, seen on the original films, had now disappeared. The rest of the stomach appeared to be normal in all respects. Films taken in upright position revealed a barium-coated oval mass in the fundus of the stomach above the layer of barium meal. The roentgen diagnosis from this study was: "Large penetrating ulcer on the lesser curvature of the stomach with a large foreign body within the stomach. In view of the remarkable improvement in the roentgen findings, I consider the ulcer to be benign, in spite of its large size."

On questioning the patient about his former diet, we obtained the history that he "ate gallons of persimmons" for several months before entering the hospital.

Upon operation the findings were as follows: The greater omentum had swung upward

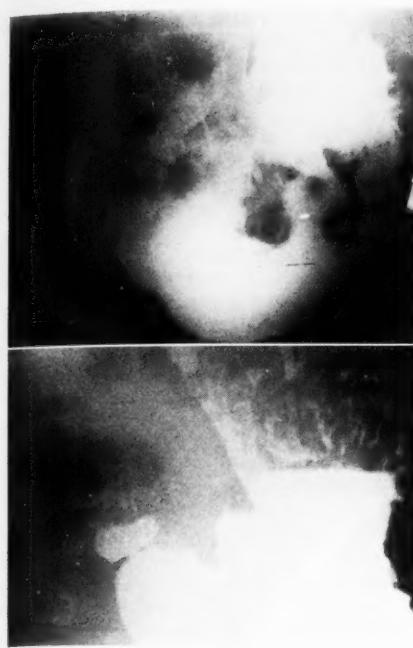


Fig. 1 (above). Film taken in the prone position, showing rarefaction and distortion at the lesser curvature of the pars media of the stomach; also, the marked defect within the middle third of the stomach.

Fig. 2 (below). Film taken 2 months after the first examination. A large penetrating ulcer is seen in the former distorted area of the lesser curvature. The phytobezoar, coated with barium, is floating above the level of the barium meal.

and was attached to a hard mass on the lesser curvature of the stomach. This dense fixed mass was about 6 cm. in diameter, firmly fixing the stomach to the underlying tissues. Upon separating the greater omentum from the mass and the lesser curvature of the stomach, a perforation about 1 cm. in diameter was uncovered. The adjacent area of the stomach proper was hard and indurated for an area of about 7 cm. The fixed mass outside the ulcer was, therefore, the organized tissue reaction which formed as a result of the perforating gastric ulcer. The indurated area of the stomach around the ulcer was considered to be benign. The large hard, stony mass within the stomach was freely movable. In view of the opening in the ulcer area which was uncovered, the ulcer and surrounding indurated area were excised and the foreign body removed through this opening on the lesser curvature of the stomach. Microscopic study of the excised ulcer did not reveal any evidence of cancer.

Figure 5 shows the phytobezoar after re-



Fig. 3. Photograph of the phytobezoar with part of the resected ulcer. The rule reads in inches.

moval. It measured 4 in. in diameter, was pitch black in color, stony hard on palpation, and resembled a piece of coal.

Conclusion.—A case of persimmon phytobezoar is presented which was incorrectly diagnosed as carcinoma of the stomach by roentgenologic studies. Re-examination two months later revealed the typical findings of a phytobezoar associated with a large penetrating ulcer on the lesser curvature of the stomach. The operative findings proved to be of unusual interest.

ISOLATED FRACTURE OF THE ATLAS¹

By STAKELY HATCHETTE, M.D., *Lake Charles, Louisiana*

Fracture of the atlas is probably among the rarest of all fractures, there having been only 99 such cases reported in the literature since 1822, when Astley Cooper reported the first of the kind, following its discovery at autopsy. Plaut (2), in an exhaustive survey of the literature, found only 93 such cases to have been reported. To this number he was able to add six new cases, all of which had occurred within recent years, and all of which followed accidents involving motor vehicles. He pointed out that such fractures are likely to become more frequent with the increasing use of automobiles and the occurrence of the type of accidents associated with them, and he suggested that roentgenologists be more on the alert to find them. The first summary of

¹ Accepted for publication in February, 1940.

fractures of the atlas was made by Jefferson (1), in 1927. He was able to find 65 such cases, 20 of which involved the atlas alone, and 45 of which were complicated by fractures elsewhere in the vertebrae or the skull. It was to this group of 65 cases that Plaut was able to add 34, 28 from a collection of case reports from the literature and the remaining six from his own practice and that of others. In bringing all reported cases of fracture of the atlas up to date, Plaut found a total of 40 cases which involved the atlas alone and 59 in which there were associated fractures in the vertebrae or skull.

The object of this paper is to report the forty-first case of fracture of this vertebra, not complicated by fractures elsewhere, and to bring the total of all reported cases up to one

hundred. For a complete summary of all previously reported cases and the names of the authors and the dates, the reader is referred to Plaut's article (2).

The location of the atlas deep within the soft tissues of the neck and the excellent protection afforded by the adjacent bony structures would make it seem almost impossible to injure it by direct violence other than by some penetrating mass which would require a wound of entry to reach the atlas. Practically all such fractures mentioned in the literature have been the result of indirect trauma as a consequence of blunt force to the skull. When one considers that the anatomic and functional characteristics of the atlas are such that it escapes the forces of longitudinal traction, of pressure, of flexion, and of extension more easily than any of the other cervical vertebrae, and that it is subject to considerably more rotation than the other vertebrae of the cervical spine, it will be understood that, as a result of these characteristics, the atlas is much less likely to be injured than any other bone in the cervical spine. If one reviews the anatomy of the atlas by examination of either the roentgenogram or the dry anatomic specimen, it will be noted that the atlas differs from the other vertebrae in that it has no body to bear weight, that all of the weight of the skull must be carried by the lateral masses, and that these lateral masses are roughly triangular in shape with their bases located laterally. As a result of this, an indirect force transmitted through the skull would have to pass through the occipital articulations of the skull to the lateral masses of the atlas, and from these lateral masses to the superior articular processes of

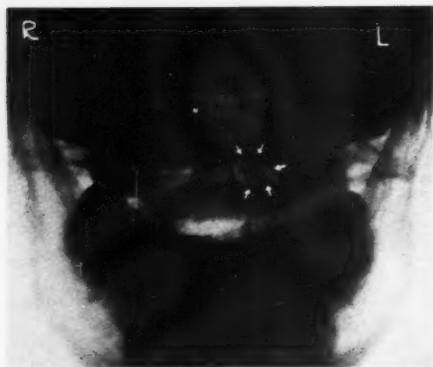


Fig. 1. Arrows indicate fracture of the anterior arch.

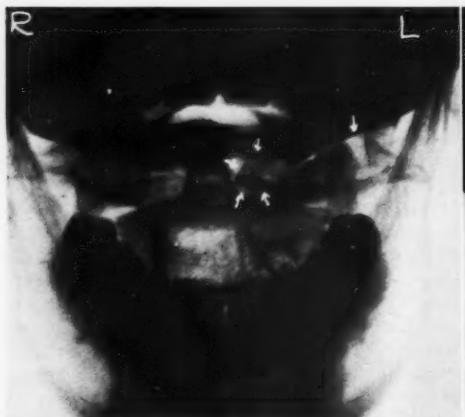


Fig. 2.

Fig. 2. Arrows indicate fracture of the anterior arch and fracture of the left transverse process.



Fig. 3.

Fig. 3. Arrows indicate slight caudal displacement of fragment from the anterior arch.

the axis. Such a force transmitted from the skull to the atlas, when met by the resistance of the articular surfaces of the spine below, would have a tendency to cause an outward spread of the ring-shaped vertebra, for the wedge-shape of the two lateral masses would account for the attempt of the vertebra to expand outwardly under force. It is more easily seen how pressure of the odontoid process against the anterior arch may cause a fracture of this area, though fracture of the odontoid is much more common. In the case of extreme deflection, the occiput may press against the spinous process of the atlas and cause fracture.

Case Report.—H. O'Q., white male, aged 29 years, employed on a drilling rig in an oil field, was referred by T. H. Watkins, M.D., for examination of the cervical spine on March 31, 1939. X-ray examination had been made on several occasions during the period between the occurrence of the injury and the roentgenologic examination reported herein. These previous examinations had been made by non-radiologists and reported as "negative." Proper positioning which would permit of demonstration of the injury was not obtained in any of these previous examinations.

The patient gave a history of having been knocked unconscious by a swinging section of drill stem while it was being dismantled and stacked in the derrick. He knew nothing that happened for several hours after he was struck but offered the opinion that the section of drill stem hit him on the left side of the neck just behind the ear. Fellow workmen told him that the weight of the swinging section of drill stem was sufficient to sweep him off of the derrick floor and that he fell some fifteen feet to strike the muddy ground below, landing on the left side of his head and his left shoulder. He stated that he was unconscious for three hours or more, and that, on regaining consciousness, he suffered from a severe pain which involved the left side of his head and neck, left shoulder, and left arm. The severe pain subsided after about two weeks, but a mild to moderate pain had remained in these areas and had persisted without change since. It had resulted in the patient assuming a posture of the neck being directed very sharply forward and somewhat toward the right, the chin being held in a moderately elevated position, and the head being moderately flexed to the left of the neck. This, he claimed, was the most comfortable position he had been able to assume since the accident.

Roentgenographic examination of the cervical spine showed no evidence of injury, disease, or abnormality in either the antero-posterior or lateral views of the section of the

spine from the third to the seventh cervical vertebra, inclusive. The anteroposterior view of the first and second cervical vertebrae showed a fracture of the anterior arch on the left side and a fracture through the left transverse process (Figs. 1 and 2). The lateral view showed a slight displacement in a caudal direction of the fragment broken away from the anterior arch (Fig. 3). This displaced fragment was exceptionally well shown on a film made by another physician soon after the accident occurred but, unfortunately, this film was not available to the writer for reproduction.

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A DEFINITE FRACTURE OF TIBIAL SESAMOID OF THE BIG TOE¹

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From the Service of L. Mayer, M.D., Hospital for Joint Diseases

A previously reported study² of the roentgenograms of 1,000 feet showed that the division of the medial (tibial sesamoid) of the big toe was noted in 7.2 per cent, and that of the lateral (fibular) sesamoid, in 0.6 per cent. The sesamoids do not obtain their center of ossification before the age of about eight or ten years and are often not completely ossified until two or three years later. Two or more centers of ossification are sometimes present.

It is reasonable to assume that in some feet these multiple centers of ossification may fail to coalesce, creating a so-called "congenital division" of the sesamoids, which persists through life.

Whether this division of the sesamoids is a genuine congenital malformation, the result of an overlooked trauma in early childhood, or a growth disturbance fitting into the group of osteochondritides (as Freiberg-Köhler's disease of the metatarsal heads, Perthes' disease of the femoral head, etc.), or possibly a combination of all the above conditions still remains a moot question.

Not infrequently, especially in legal cases, the question arises as to whether we are dealing

¹ Accepted for publication in April, 1940.

² Burman, M. S., and Lapidus, P. W.: The Functional Disturbances Caused by the Inconstant Bones and Sesamoids of the Foot. *Arch. Surg.*, **22**, 936-975, June, 1931.

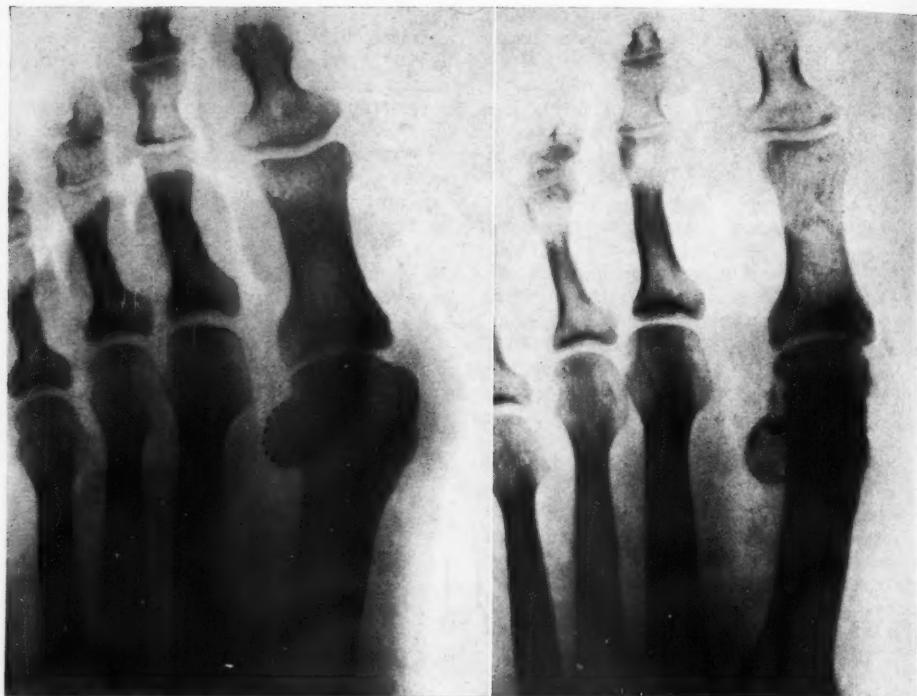


Fig. 1.

Fig. 1. Roentgenogram of the left foot taken on Feb. 12, 1934, before the operation for hallux valgus. Both sesamoids (retouched) of the big toe are normal.

Fig. 2. Roentgenogram of the same foot taken on Aug. 14, 1934, about six months after the operation, and four months after the injury. Note the oblique fracture of the medial (tibial) sesamoid (retouched) of the big toe.

with a fracture resulting from a recent injury, or with a pre-existing congenital division of the sesamoid. Although some observers claim that the edges of the fragments are smooth in congenitally divided sesamoids while they present a serrate-like appearance in cases of fracture, we feel that the roentgenographic picture is rather similar in both cases, and certainly cannot be relied upon for a definite differential diagnosis.

Likewise, the clinical findings are frequently confusing. A congenitally divided sesamoid may become painful and tender following a strain or a trauma, while, on the other hand, a true fracture may cause comparatively little discomfort, especially if the patient is examined a few days after the injury.

Therefore, a definite diagnosis of a fracture is often very difficult and often can be arrived at only with a fair amount of probability. The case here reported is considered an extreme rarity because of an unusual coincidence

which made it possible to diagnose it as an undeniable fracture of the sesamoid.

Report of Case.—A colored woman, 31 years old, was operated upon for mild bilateral hallux valgus, on Feb. 14, 1934 (removal of bony projection and reefing of medial capsule). The roentgenogram made before the operation (Fig. 1), and likewise the post-operative one, showed normally shaped sesamoids under the first metatarsal heads. On April 18, 1934, while walking downstairs the patient stubbed her left toes against a step and fell. The left foot was apparently in marked equinus with the toes forcefully brought into plantar flexion.

The patient remained confined to bed because of considerable pain, and was first seen in the clinic on April 24, 1934. She avoided weight-bearing on the ball of the left big toe, and a slight puffiness was noted over this area. There were no ecchymoses. Active and passive motions of the big toe, even when performed against resistance, were free and painless. Be-

cause of a strictly localized tenderness over the region of the tibial sesamoid of the big toe, a clinical diagnosis of fracture of the sesamoid was made. This was later confirmed roentgenologically.

Felt padding was applied and physiotherapy given. By the end of a month the tenderness had gradually disappeared, the actual severe disability lasting only about one week. Evidently the fragments became united only by fibrous union, as the line of the fracture was still visible on a roentgenogram (Fig. 2) taken on Aug. 14, 1934, but the foot had remained symptom-free.

SUMMARY

Definite recognition of a fracture from a congenital division of the sesamoid of the big toe is often impossible. Conservative treatment in both conditions is, as a rule, successful.

Removal of the sesamoid should be reserved for only those rare, exceptionally stubborn cases, and then only after failure of conservative treatment.

A definite fracture of the medial (tibial) sesamoid is recorded. The diagnosis was possible because, coincidentally, roentgenograms of the feet made before the injury were available.

SELECTIVE SERVICE EXAMINATIONS

Responding to a series of bulletins sent out by the American College of Radiology, secretaries of regional radiological societies and members serving as State representatives of the Inter-Society Committee and of the American College of Radiology have set up machinery in the various states to permit the radiological societies in their respective localities to assist in the program for examining registrants under the Selective Service Act.

With the exception of three or four States not yet heard from, conferences between a special "Advisory Committee on Radiology" or a group representing the local society have been held with the State Society Committee on Medical Preparedness. In some instances negotiations have been conducted directly between the radiological representatives and the State Selective Service Administration.

As stated in the Bulletin appearing in the December issue of this JOURNAL, physicians are contributing their services in the national defense program by examining registrants called under the Selective Service Act, without charge. For special procedures, such as laboratory analyses, x-ray examinations, etc., provision has been made to reimburse physicians for the cost of supplies used. It has been recommended that some uniform schedule be adopted in the various States, upon the basis of which reimbursement will be made.

Originally it was planned to submit a schedule to be prepared by a committee appointed by the American Medical Association Committee on Medical Preparedness. For numerous reasons this idea was abandoned and a separate schedule is to be adopted in each State. In all States except Wisconsin, payment will be made, as provided by the Act, on bills submitted to the State Procurement Officer.

In Wisconsin, radiologists, pathologists, and others performing special examinations will be reimbursed upon a cost-basis from a special fund set up by the State Medical Society. The State Society will itself assume the responsibility of defraying these costs on the basis of an agreed schedule. This method

will be followed for a trial period of 90 days and at that time decision will be reached as to whether the plan shall be continued or the charges be paid from government funds.

In several ways this plan is a desirable one. Among other things, it will obviate the unsatisfactory situation of having a "supply-cost" schedule distributed for x-ray procedures which some persons may erroneously assume to represent the actual cost for x-ray examinations. The fears of some members in this regard may be unwarranted, however, in view of the fact that approved cost schedules will not be generally distributed and will be used only by the Selective Service Board for the purpose they were intended, to defray costs only.

This question of the possible injurious effects of these schedules has been frequently referred to in the very great amount of correspondence pertaining to the Selective Service program received at College headquarters. One member has urged that they be referred to, not as "cost schedules," but as "cost of film schedules." He recommends that, "each radiologist making these examinations keep a list of the films actually used and an actual cost of these films be turned in. It gets away from the idea of a fee schedule and sets no precedent." He further suggests that the sums involved are so small "that it is of no consequence and may lead to future events which will be of considerable consequence. Furthermore, it is my understanding," he continues, "that the internists and other physicians making these examinations are receiving no fees for their services. My point is that we should be upon exactly the same basis as any other physician. Overhead, such as charges for secretaries, technicians, etc., should not be considered, as it is my understanding that other physicians are making no charge for office expenses."

There is a considerable group which feels that complete *actual* costs should be defrayed. During a meeting of the Executive Committee of the College, some time ago, it was decided that, in view of different circumstances in

different localities, and the divergence of opinion manifested, no recommendation should be made by the College for the nation as a whole.

Nearly a score of States have adopted cost schedules submitted by the Advisory Committee on Radiology or some group of radiologists acting in a similar capacity. By far the greater portion have adopted a schedule which approximates, roughly, in the majority of items, about 50 per cent of the prevailing fees for private or compensation work. In others, the cost schedules approximate more nearly 25 per cent of the prevailing fees. In Pennsylvania, a schedule equalling about one-third of the compensation schedule has been submitted. It is reported that radiologists in the District of Columbia are assuming the costs themselves and are making no charges.

The first schedule reported was for New York State and the items therein amounted to about 25 per cent of the compensation schedule. According to information received from the chairman of the New York Committee on Medical Preparedness, the schedule has not been formally adopted and may be revised. The Iowa X-ray Club was one of the earliest State societies to submit and receive the approval of a cost schedule. The Iowa schedule approximates 50 per cent of the industrial compensation schedule. It has been adopted, with slight variations, for use in a number of other States.

MAC F. CAHAL,
Executive Secretary.

RADIOLOGICAL SOCIETIES IN NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

UNITED STATES

CALIFORNIA

California Medical Association, Section on Radiology.—Chairman, Carl H. Parker, M.D., 65 N. Madison Ave., Pasadena; Secretary, Wilbur Bailey, M.D., 2007 Wilshire Blvd., Los Angeles.

Los Angeles County Medical Association, Radiological Section.—President, M. L. Pindell, M.D.; Vice-president, Richard T. Taylor, M.D.; Secretary, Wilbur Bailey, M.D., 2007 Wilshire Blvd.; Treasurer, Henry Snure, M.D., 1414 South Hope Street; Kenneth Davis, M.D., Member of Executive Committee. Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Chairman, William E. Costolow, M.D., Los Angeles; Members of Executive Committee, I. S. Ingber, M.D., San Francisco; D. R. MacColl, M.D., Los Angeles, and J. D. Coate, M.D., Oakland; Secretary-Treasurer, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Executive Committee meets quarterly; Society meets annually during annual meeting of the California Medical Association.

San Francisco Radiological Society.—Secretary, Harold A. Hill, M.D., 450 Sutter Street. Meets monthly on third Thursday at 7:45 P.M., for the first six months at Toland Hall (Univ. of Calif. Med. School) and for the second six months at Lane Hall (Stanford Univ. School of Med.).

COLORADO

Denver Radiological Club.—President, N. B. Newcomer, M.D., 306 Republic Bldg.; Vice-president, Elizabeth Newcomer, M.D.; Secretary, Paul R. Weeks, M.D., 520 Republic Bldg.; Treasurer, L. G. Crosby, M.D., 366 Metropolitan Bldg. Meets third Friday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Chairman, Owen J. Groark, M.D., 881 Lafayette St., Bridgeport; Secretary-Treasurer, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

FLORIDA

Florida Radiological Society.—President, J. H. Lucinian, M.D.; Vice-president, John N. Moore, M.D.; Secretary-Treasurer, Elliott M. Hendricks, M.D., 314 Sweet Bldg., Fort Lauderdale. The next meet-

ing will be at the time of the annual meeting of the Medical Association of Florida in the spring.

GEORGIA

Georgia Radiological Society.—President, Robert Drane, M.D., DeRenne Apts., Savannah; Vice-president, J. J. Collins, M.D., Archbold Hospital, Thomasville; Secretary-Treasurer, Robert C. Pendergrass, M.D., Prather Clinic Bldg., Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—President, Adolph Hartung, M.D.; Vice-president, Warren W. Furey, M.D.; Secretary, Chester J. Challenger, M.D., 3117 Logan Blvd. The Society meets at the Palmer House on the second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—President, Harry W. Ackeman, M.D., 321 W. State St., Rockford; Vice-president, D. R. Hanley, M.D., St. Mary's Hospital, Streator; Secretary-Treasurer, William DeHollander, M.D., St. John's Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Chairman, Harry W. Ackeman, M.D., 321 W. State St., Rockford; Secretary, Earl E. Barth, M.D., 303 E. Chicago Ave., Chicago.

INDIANA

The Indiana Roentgen Society.—President, H. H. Inlow, M.D., Shelbyville; President-elect, Charles Wyeth, M.D., Terre Haute; Vice-president, C. A. Stayton, M.D., Indianapolis; Secretary-Treasurer, Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—President, D. B. Harding, M.D., Lexington; Vice-president, I. T. Fugate, M.D., Louisville; Secretary-Treasurer, Joseph C. Bell, M.D., 402 Heyburn Bldg., Louisville. Meeting annually in Louisville, third Sunday afternoon in April.

LOUISIANA

Shreveport Radiological Club.—President, C. P. Rutledge, M.D.; Vice-president, S. C. Barrow, M.D.; Secretary-Treasurer, W. R. Harwell, M.D. Meetings monthly on the second Wednesday, at the offices of the various members.

MAINE

See New England Roentgen Ray Society.

MARYLAND

Baltimore City Medical Society, Radiological Section.—*President*, John W. Pierson, M.D., 1107 St. Paul St.; *Secretary*, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

The Thirty-first Annual Midwinter Conference of Eastern Radiologists will meet in Baltimore on Jan. 31 and Feb. 1, 1941.

MASSACHUSETTS

See New England Roentgen Ray Society.

MICHIGAN

Detroit X-ray and Radium Society.—*President*, O. J. Shore, M.D., 552 Fisher Bldg., Detroit; *Vice-president*, Clarence E. Hufford, M.D., 421 Michigan St., Toledo, Ohio; *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—*President*, J. H. Dempster, M.D., Detroit; *Vice-president*, L. E. Holly, M.D., Muskegon; *Secretary-Treasurer*, J. E. Lofstrom, M.D., 1536 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—*President*, Harry Weber, M.D., Mayo Clinic, Rochester; *Vice-president*, G. T. Nordin, M.D., Minneapolis; *Secretary*, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

MISSOURI

The Kansas City Radiological Society.—*President*, Galen M. Tice, M.D., Univ. of Kansas Hospitals, Kansas City, Kansas; *Secretary*, P. E. Hiebert, M.D., 907 North Seventh St. (Huron Bldg.), Kansas City, Kansas. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—*President*, Oscar C. Zink, M.D., St. Luke's Hospital; *Secretary*, Wilbur K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—*President*, H. A. Scott, M.D., Veterans Administration Facility, Lincoln; *Secretary*, D. A. Dowell, M.D., 816 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *Secretary*, Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

Radiological Society of New Jersey.—*President*, James G. Boyes, M.D., 912 Prospect Ave., Plainfield; *Vice-president*, Nathan J. Furst, M.D., 190 Johnson Ave., Newark; *Secretary*, W. James Marquis, M.D., 198 Clinton Ave., Newark; *Treasurer*, H. A. Vogel, M.D., 1060 East Jersey St., Elizabeth, and *Counselor*, H. J. Perlberg, M.D., 921 Bergen Ave., Jersey City. Meetings at Atlantic City at time of State Medical Society and Midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.—*President*, I. J. Landsman, M.D., 910 Grand Concourse, New York City; *President-elect*, D. E. Ehrlich, M.D., 35 West 92nd St., New York City; *Vice-president*, Frederic E. Elliott, M.D., 122 76th St., Brooklyn; *Treasurer*, Solomon Fineman, M.D., 133 East 58th St., New York City; *Secretary*, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—*President*, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts.; *Secretary-Treasurer*, L. J. Taormina, M.D., 1093 Gates Ave. Meetings held the fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—*President*, Edward Koenig, M.D., 100 High St., Buffalo; *Vice-president*, W. Roger Scott, M.D., 598 Pine St., Niagara Falls; *Secretary-Treasurer*, Joseph S. Gian-Franceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Ray Society.—*President*, Albert Lenz, M.D., 613 State St., Schenectady; *Vice-president*, Dwight V. Needham, M.D., 123 Sedgwick St., Syracuse; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—*President*, Samuel G. Schenck, M.D., Brooklyn; *Vice-president*, G. Henry Koiransky, M.D., Long Island City; *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn; *Treasurer*, Louis Goldfarb, M.D., 608 Ocean Ave., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—*President*, Henry K. Taylor, M.D., 667 Madison Ave., New York City;

Vice-president, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains, N. Y.; *Secretary*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City, and *Treasurer*, Paul C. Swenson, M.D., 168th St. and Broadway, New York City.

Rochester Roentgen-ray Society.—*Chairman*, George H. S. Ramsey, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—*President*, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

Ohio Radiological Society.—*President*, U. V. Portmann, M.D., Cleveland; *Secretary*, J. E. McCarthy, M.D., Cincinnati. A committee was appointed to draw up a constitution and by-laws. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—*President*, L. A. Pomeroy, M.D., Hanna Bldg., Cleveland; *Vice-president*, P. C. Langan, M.D., 215 Wellesley Ave., Akron; *Secretary-Treasurer*, H. A. Maher, M.D., 10515 Carnegie Ave., Cleveland. Meetings at 6:30 P.M. at the Mid-day Club, in the Union Commerce Bldg., on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President*, Samuel Brown, M.D.; *Secretary-Treasurer*, Justin E. McCarthy, M.D., 707 Race St. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—*President*, H. Norton Mawhinney, M.D., Pittsburgh; *President-elect*, Peter B. Mulligan, M.D., Ashland; *First Vice-president*, Harold S. Callen, M.D., Bradford; *Second Vice-president*, Harold W. Jacox, M.D., Pittsburgh; *Secretary-Treasurer*, L. E. Wurster, M.D., 416 Pine St., Williamsport; *Editor*, William E. Reiley, M.D., Clearfield; *Assistant Editor*, Sydney J. Hawley, M.D., Danville; *Censor for Three Years*, A. R. Snedden, M.D., McKeesport. The Society meets annually; time and place of next meeting will be announced later.

The Philadelphia Roentgen Ray Society.—*President*, Jacob H. Vastine, II, M.D., Medical Arts Bldg., Philadelphia; *Vice-president*, A. Maxwell Sharpe,

M.D., 708 Sproul St., Chester; *Secretary*, Barton R. Young, M.D., Temple University Hospital, Philadelphia; *Treasurer*, Fay K. Alexander, M.D., Chestnut Hill Hospital, Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

The Pittsburgh Roentgen Society.—*President*, Paul G. Bovard, M.D., 306 Corbett St., Tarentum, Pa.; *Vice-president*, John H. Gemmell, M.D., 262 Connecticut Ave., Rochester, Pa., and *Secretary-Treasurer*, Harold W. Jacox, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—*President*, T. A. Pitts, M.D., Columbia; *Secretary-Treasurer*, Malcolm Mosteller, M.D., Columbia Hospital, Columbia. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—*President*, Eugene Abercrombie, M.D., 305 Medical Arts Bldg., Knoxville; *Vice-president*, Christopher C. McClure, M.D., 404 Doctors Bldg., Nashville; *Secretary-Treasurer*, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—*President*, C. F. Crain, M.D., Corpus Christi; *President-elect*, M. H. Glover, M.D., Wichita Falls; *First Vice-president*, G. D. Carlson, M.D., Dallas; *Second Vice-president*, P. E. Wigby, M.D., Dallas; *Secretary-Treasurer*, L. W. Baird, M.D., Scott and White Hospital, Temple. Meets annually. The next annual meeting is to be Jan. 18, 1941, in Sherman.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Virginia Radiological Society.—*President*, Wright Clarkson, M.D., Petersburg; *Vice-president*, Clayton

W. Ely, M.D., Norfolk; *Secretary*, Charles H. Petersen, M.D., 603 Medical Arts Bldg., Roanoke.

WASHINGTON

Washington State Radiological Society.—*President*, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Vice-president*, George Cornett, M.D., Yakima; *Secretary-Treasurer*, Kenneth J. Holtz, M.D., American Bank Bldg., Seattle. Meetings fourth Monday of each month at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—*President*, H. W. Hefke, M.D.; *Vice-president*, Frederick C. Christensen, M.D.; *Secretary-Treasurer*, Irving I. Cowan, M.D., Mount Sinai Hospital, Milwaukee. Meets monthly on first Friday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—*Secretary*, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—*Secretary*, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 p.m., Room 301 Service Memorial Institute.

CANADA

Section on Radiology, Canadian Medical Association.—*Chairman*, Gordon Richards, M.D., Medical Arts Bldg., Toronto; *Secretary*, W. J. Cryderman M.D., Medical Arts Bldg., Toronto.

Section on Radiology, Ontario Medical Association.—*Chairman*, E. H. Shannon, M.D., St. Michael's Hospital, Toronto; *Secretary*, W. J. Cryderman, M.D., 474 Glenlake Avenue, Toronto.

Canadian Association of Radiologists.—*President*, J. E. Gendreau, M.D., Montreal; *Vice-president*, W. H. McGuffin, M.D., Calgary; *Honorary Secretary-Treasurer*, W. L. Ritchie, M.D., Montreal; *Chairman of Interrelations Committee*, G. E. Richards, M.D., Toronto.

La Société Canadienne-Française d'Electrologie et de Radiologie Médicales held a meeting at Quebec on Sept. 28, 1940, at which time the following officers were elected for the next two years: *President*, Albert Comtois, M.D., Hôpital Ste.-Justine, Montreal; *First Vice-president*, Jules Gosselin, M.D., Hôpital St.-Sacrement, Quebec; *Second Vice-president*, Paul Brodeur, M.D., General Hospital, Ottawa; *General Secretary*, Origène Dufresne, M.D., Institut du Radium, Montreal, and *General Treasurer*, Doriva Léonard, M.D., Hôpital Notre Dame, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

EDITORIAL ANNOUNCEMENT

It is felt that by making the following announcement a month in advance of the actual change of editorship, those men who have had contributions accepted for publication in *RADIOLOGY* will be assured that their papers are in competent hands and that they may be sure of the orderly progression of the *JOURNAL*.

At the Annual Meeting in Cleveland, Dr. Leon J. Menville resigned as Editor, to be succeeded by Dr. Howard P. Doub, of the Henry Ford Hospital, Detroit, under whose capable management the *JOURNAL* will continue publication without interruption. It may be that announcement will be made in a later issue of a change in street address merely, but those wishing to do so may reach Dr. Doub as above.

Dr. Doub is well known to the members of the Radiological Society of North America, of which he was President for the year 1938: in fact, since 1935 he has been almost continuously a member of the Executive Committee. He holds a commanding position in his own city, and has been Associate Editor of *RADIOLOGY* since 1934, following the death of Dr. Allen, of Florida. He has been a frequent contributor to the *JOURNAL*, his papers being

invariably of a high order. Dr. Doub is a man it is most easy to like immensely, since he has in a high degree the qualities of the ideal physician.

The *JOURNAL* was founded in 1923, by Dr. M. J. Hubeny, of Chicago, who set a policy of publishing a journal which should be of distinct usefulness to the average radiologist and to the younger men in our specialty. So successfully did he build the *JOURNAL* into the needs of these men that when Dr. Menville took over the editorship in 1931 he sought to continue the same policy. Since 1932 the Editor has had the valuable co-operation of Dr. Donald S. Childs, of Syracuse, who, as Business Manager, has had full control of the advertising printed in the *JOURNAL*, has carried the responsibility of its finances and circulation, and has at all times participated to a large degree in shaping its policies. To Dr. Childs the retiring Editor owes a deep sense of gratitude.

Under the editorship of Dr. Doub and the Publication Committee we foresee the *JOURNAL* passing into its third period of growth and leadership in the field of radiological literature, and our heartiest good wishes are with the new Editor.

ANNOUNCEMENT

AMERICAN RADIUM SOCIETY

The annual meeting of the American Radium Society will be held on June 2 and 3, 1941, in Cleveland, Ohio. The Hotel Cleveland has been selected as headquarters.

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

GANG UND TECHNIK DER RÖNTGENUNTERSUCHUNG AUF HARNSTEINE (Progress and Technic of Roentgen Examination for Urinary Calculi). By Dr. EDUARD PFLAUMER, Professor of Radiology at the University

of Erlangen, Head of the Urologic Clinic at the City Hospital of Nuremberg, and Dr. HERMANN FRIEDRICH, Chief Physician of the Urologic Clinic. A monograph containing 95 pages, with 120 illustrations. Published by Georg Thieme, Leipzig, 1940. Price: 8 R.M. (A 25 per cent discount allowed to foreign purchasers.)

HANDBUCH DER ERBKRANKHEITEN (Hereditary Diseases). Vol. VI. Edited by Dr. ARTHUR GUTT, Potsdam, Secretary to the 88th SS. Brigade Leader. **DIE ERBLICHE TAUBHEIT** (Hereditary Deafness and its Diagnosis). By Dr. M. SCHWARZ, Professor and Director of the University Ear-nose-throat Clinic, Frankfort on Main, and **KORPERLICHE MISSBILDUNGEN** (Bodily Deformities). By Dr. HELMUT ECKHARDT, Specialist in Orthopedics, Chief of Division II, National Health Inspection, of the National Board of Health Service and the National Associates for the Prevention of Cripplessness. A volume of 373 pages, with 222 illustrations. Published by Georg

Thieme, Leipzig, 1940. Price: Bound 26.00 R.M. (A 25 per cent discount allowed to foreign purchasers.)

DIAGNOSIS AND TREATMENT OF MENSTRUAL DISORDERS AND STERILITY. By CHARLES MAZER, M.D., F.A.C.S., Assistant Professor of Gynecology and Obstetrics, Graduate School of Medicine, University of Pennsylvania; Gynecologist to the Mount Sinai Hospital, Philadelphia, and S. LEON ISRAEL, M.D., F.A.C.S., Instructor in Gynecology and Obstetrics, School of Medicine, University of Pennsylvania; Associate Gynecologist to the Mount Sinai Hospital, Philadelphia. A volume of 485 pages, with 108 illustrations. Published by Paul B. Hoeber, Inc., New York City, 1941. Price: \$6.50.

FRACTURES AND DISLOCATIONS. By EDWIN O. GECKELER, M.D. Second revised edition. A volume containing 314 pages. Published by the Williams & Wilkins Company, Baltimore, 1940. Price: \$4.00.

ABSTRACTS OF CURRENT LITERATURE

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THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S. M. ATKINS, M.D., of Waterbury, Conn.
 W. R. BROOKSHER, M.D., of Fort Smith, Ark.
 J. J. CLARK, M.D., of Atlanta, Ga.
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 M. L. CONNELLY, M.D., of Chicago
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THE ABDOMEN

Newer Aspects of Abdominal Roentgenology. Charles F. Behrens. U. S. Nav. Med. Bull., **38**, 47-52, January, 1940.

Dr. Behrens presents in this article a comprehensive review of the advantages of the use of roentgenology in abdominal diagnosis. Of special interest is his statement that, "The most convincing picture of gastritis includes the following combination of signs: (1) coarse rugal folds; (2) disordered peristalsis, especially peristalsis of hectic fibrillary type; (3) undue clinging of barium to the walls, together with granular mottling; (4) increased tonicity. In duodenitis we tend to find: (1) increased tone; (2) coarsened mucosal pattern and tendency to ragged outlines, and (3) disordered motility of the duodenal contents."

He calls attention to the fact that peptic ulcers are closely associated with gastritis and duodenitis.

ANTONIO MAYORAL, M.D.

APPARATUS

A Fluoroscopic Picture Apparatus for Clinical Use. K. L. Schmidt. München. med. Wehnschr., **87**, 68-70, Jan. 19, 1940.

The author describes his apparatus on account of its cheapness. He used a Bucky table with an old fluoroscopic screen stand. By swinging the tube around from the table he saved the cost of another tube (it was a rotating anode type). The tube was fastened with braces to the fluoroscopic screen so that they moved simultaneously. The screen itself was a Superastral, attached to a lead-lined telescope terminating in the camera, a Leica III. The focal-screen distance was 80 cm.; the screen-film distance, 98.6 cm. The exposure ran about 0.2 second. The lens in the camera was a 1:2. The apparatus had the advantage of being usable in the horizontal position.

The films were examined with a projector; for this the Leica lens may be employed to save expense, or, if the number of films is small, they may be examined with a loupe. An enlargement 6 × 6 is made. Development was in an Agfa metol-hydroquinone developer slowed with "Bromkali." The cost of the installation was between 800 and 900 R.M. (about \$320 to \$360 at present exchange). The apparatus is highly useful for securing routine chest films on all patients and for periodic follow-up,¹ it is possible that it could be adapted to gastro-intestinal and cholecystographic work.

LEWIS G. JACOBS, M.D.

The Fluoroscopic Photograph in the Service of the Clinic. W. Schöndube. München. med. Wehnschr., **87**, 70, Jan. 19, 1940.

The author discusses the practical aspects of the use of miniature photographs of the fluoroscopic image of the chest taken with the apparatus described in the previous article.² He secures a routine postero-anterior

¹ See following abstract.

² See preceding abstract.

study, plus anteroposterior and oblique views when indicated, on all patients on designated days. Full size roentgenograms and follow-up studies at weekly intervals were secured in all cases in which these procedures seemed useful. The author particularly stresses the fact that miniature films are essential in working up a case of heart disease, as well as in pulmonary affections. The cost of the examination is small, and a 6 × 6 enlargement can be permanently filed in the case history. A number of illustrations show the appearances in typical cases.

LEWIS G. JACOBS, M.D.

Physical Investigation of the Contribution of the Photo-electrons from Sulphur to X-ray Ionization. L. H. Gray. British Jour. Radiol., **13**, 25-30, January, 1940.

Measurements were made of the increase in energy increment per unit volume of tissue completely surrounded with sulphur, and with 14 μ and 70 μ of tissue intervening as absorbing material at 190 kv. and 117 kv. Details of the apparatus and methods are given.

Pure sulphur causes an increment of 1.91 at 190 kv. and 5.08 at 117 kv. With 14 μ of absorbing tissue the increment for both voltages is practically the same. This is about 100 per cent more than with the same number of r with gamma radiation. This corresponds to observed results in biologic experiments.

Investigations were also made of ionization at the center of spheres of different size containing high atomic number elements, and the effective wave length of the radiation deduced from the magnitude of the photoelectric absorption. Measurements were made with ionization chambers having dissimilar walls.

SYDNEY J. HAWLEY, M.D.

ASPERGILLOSIS, PULMONARY

Pulmonary Aspergillosis, with Report of a Case H. Scott Van Ordstrand. Cleveland Clin. Quart., **7**, 66-73, January, 1940.

Aspergillus is one of many fungi which may infect the lungs, producing symptoms and roentgen findings similar to those of tuberculosis. Aspergillosis is usually found in those persons caring for pigeons and other birds, and among those in close contact with grains. The disease may be a secondary invader in tuberculosis and *vice versa*.

Symptomatically the disease may resemble an acute or chronic bronchitis, tuberculosis, or pneumonia. There are a variety of roentgen appearances of the chest, the most typical probably being an increase in the hilar shadows with a radiating spider-web appearance, the so-called "sun-burst" effect. The changes are more usually basal in location.

Diagnosis is made on suspicion of the disease, the recovery of the fungus, and elimination of other causes of infection.

Iodides, arsenicals, and thymol are the therapeutic agents.

A case report is offered, describing in detail the clinical findings and roentgen appearance of the chest.

JOHN B. MCANENY, M.D.

BIOLOGIC EXPERIMENTATION

The Relative Response of the Skin of Mice to X-radiation and Gamma Radiation. J. C. Mottram and L. H. Gray. British Jour. Radiol., **13**, 31-34, January, 1940.

Equal-sized sections of the tails of mice were irradiated with equal quantities of x-radiation and gamma radiation, measured in roentgens. The time factor was the same for both types. In each instance the effect from x-radiation was the greater. Although the dose applied was the same, it does not follow that the energy affecting the tissues was the same. The calcium in the bones and the sulphur in the skin would give rise to different amounts of photo-electrons with the two applied radiations. As under x-radiation, the photo-electron emission is higher, which may account for the difference in observed effect.

SYDNEY J. HAWLEY, M.D.

Effect of Radiation on *Drosophila* Eggs. H. Langendorff and K. Sommermeyer. Strahlentherapie, **67**, 119-129, January, 1940.

The authors constructed a condenser x-ray apparatus with very high output. By using a specially designed x-ray tube it was possible to obtain outside of the tube window 2,000 r in 1/10 second per discharge. *Drosophila* eggs of various ages were exposed to such a "radiation impact." No influence of the time factor could be observed. The authors assume, therefore, that the time factor effect which is noticed during long exposures is due to a biologic phenomenon, namely, the growth of the eggs during irradiation.

ERNST A. POHLE, M.D., Ph.D.

The Applicability of the Epidermis of Allium for Radiobiological Experiments. Ferdinand Hercik, M. Klusakova, and F. Zeman. Strahlentherapie, **67**, 251-265, March, 1940.

The authors state that the epidermis of allium (onion skin) is a suitable test object for radiobiological experiments. The method for the isolation of the epidermis is simple: a number of special chambers where the test object can be irradiated are described. Three methods have been used so far, to report radiation effects: the plasmolytic, the erythrosin, and the fluorescence methods. The susceptibility to alpha rays was determined; the half value dose corresponds to approximately 5×10^6 r. The influence of temperature, space factor, and water content of epidermis on the reaction to irradiation were also studied.

ERNST A. POHLE, M.D., Ph.D.

BONES, DISEASES

Fragilitas Osseum: Brittle Bones and Blue Sclera: Hereditary Mesenchyme Hypoplasia. Bernard H. Nichols. Cleveland Clin. Quart., **7**, 58-65, January, 1940.

This is a case report of a 31-year-old male. At the age of seven and one-half years, skull enlargement was noted and after his seventeenth year he began to have a series of fractures of various bones. His sclera were always blue and he had bony exostosis of the left auditory canal with diminished hearing in this ear.

On roentgen examination the skull showed changes typical of Paget's disease; the pelvis and femurs showed typical osteitis fibrosa cystica; there was a right dorsal scoliosis of the thoracic spine and cystic formation of the ribs, and there was generalized malacia of the bones of the hands and the bones about the knees.

Exploration of the parathyroids revealed one gland two and one-half times its normal size, which was removed and proved to be normal on histologic section. There was no improvement in the patient's condition.

JOHN B. MCANENY, M.D.

Dysostosis Multiplex. James B. Gillespie and John A. Siegling. Jour. Bone and Joint Surg., **22**, 171-175, January, 1940.

This is a syndrome characterized by congenital clouding of the cornea, scaphocephalic head, kyphosis, limited motion of the joints of the extremities, and other anomalies. It is a rare condition and is a subvariety of chondrodystrophy.

A case report is presented in which the additional features of cretinism and possibly rickets occur.

The characteristic findings are a congenital condition with cloudy cornea and scaphocephaly, and accompanied by generally retarded mentality.

JOHN B. MCANENY, M.D.

THE BRAIN

The Effect of X-ray Deep Therapy on Gliomatous Brain Tumors. Wilhelm Rüsken. Strahlentherapie, **67**, 205-218, March, 1940.

After a brief discussion of the present status of the treatment of glioma the author reports in detail the history of a man, 53 years of age, who developed epileptic attacks in 1936. Thorough study in the clinic in June, 1937, revealed a tumor, probably glioma, in the left parietotemporal region. After intensive x-ray therapy—five fields, 2,700 r per area, through 0.5 mm. Cu—the patient improved so much that he could be discharged to work on his farm. Two and one-half years later he had some headaches, but not severe; encephalograms did not show any signs of tumor but rather indicated a slight brain atrophy. This is explained on the basis of the shrinkage of the mass originally present following x-ray therapy.

The author believes that it is advisable to irradiate a higher percentage of these gliomas without operation,

provided that the patients are carefully observed during treatment.

ERNST A. POHLE, M.D., Ph.D.

The X-ray Diagnosis of Brain Tumors. Carl L. Gillies. *Jour. Iowa St. Med. Soc.*, **30**, 21, 22, January, 1940.

The author reviews briefly the roentgen findings in brain tumors. Aside from the indirect signs of intracranial neoplasms, such as evidence of increased pressure, displacement of a calcified pineal, and sellar erosion, there may be localizing evidence of the tumor itself without the use of contrast media in the ventricular system. Meningiomas are the most important from the standpoint of the production of direct signs. Hypervascularity, erosion or production of bone, and calcification within the tumor may be seen. Rathke-pouch tumors are prone to calcify and occur most commonly in children. Of the cerebral gliomas, the oligodendrogliomas being slow-growing often show evidence of calcification. The same is true of the more common astrocytomas. The other gliomatous tumors rarely, if ever, show calcification but may, if close to the surface of the brain, show evidence of pressure atrophy of the internal table. The cerebellar tumors are usually found in children. The rapidly growing medulloblastomas may show separation of the sutures but are not likely to cause increased digital markings. The astrocytomas, on the other hand, are very slow-growing and marked evidence of increased intracranial pressure is likely to be present. The ependymomas are prone to calcify and any tumor in the cerebellum in a child showing calcium is almost sure to be one. Of the pituitary tumors, the chromophobe adenoma produces the characteristic picture of a greatly enlarged, ballooned-out sella. The eosinophile tumor enlarges the sella slightly, if at all, but the changes of the accompanying acromegaly will be shown on the films. The basophilic tumor produces no sellar changes but there is an accompanying decalcification of the bones of the skull similar to that seen in hyperthyroidism.

LESTER W. PAUL, M.D.

BRONCHIECTASIS

Compensatory Emphysema of the Lungs in Bronchiectasis. Wilm Kohlbach. *Röntgenpraxis*, **12**, 58-61, February, 1940.

Bronchiectasis might at times be diagnosed on roentgen films by the finding of ring shadows and increased bronchial markings. It is unusual, but possible, to find localized areas of increased air content due to an emphysema distal to partial obstruction of secretion-containing bronchi. If this is the case, all changes indicating a fibrotic process disappear and the only sign of bronchiectasis might be a localized emphysema. The occurrence of this sign is not frequent. The author reports two cases.

HANS W. HEFKE, M.D.

CANCER

Experience with Thorium X Rods in the Treatment of Skin Carcinoma and Vascular Nevi. K. Hoede and F. Schaefer. *Strahlentherapie*, **67**, 23-38, January, 1940.

Thin rods (seeds) of thorium x either unfiltered, gold plated, or filtered through 0.1 mm. Au, the latter being removable, were used by the authors in the treatment of skin cancer and vascular nevi. The unfiltered seeds remain in the tissue; in 40 days the radio-activity has been spent. They use 0.5 mc. thorium x per seed. The technic of implantation is described in detail. The seeds remain *in situ* for from three to eight days in cases of carcinoma and from three to five days in cases of angioma. Fifty-three advanced carcinomas of the skin, many of which had been treated before by other methods, are analyzed: twenty-four remained well for a period of from one to ten years. Supplementary x-ray therapy is often desirable and very effective (150 per cent H.E.D. in one sitting or three or four \times 50 per cent H.E.D.; 0.3 mm. Cu + 1 mm. Al). Forty-six cases with angioma (two in adults, 44 in children) were successfully treated without a single failure; some required repeated implantation. Illustrations of a few selected cases of carcinoma and angioma before and after treatment are appended.

ERNST A. POHLE, M.D., Ph.D.

Cancer of the Breast. I. Ridgeway Trimble. *Surg., Gynec. and Obst.*, **70**, 82-92, January, 1940.

In a comprehensive article the author describes in detail the technic of the radical breast amputation, the effectiveness of which he states is dependent upon the completeness with which it is performed. Pre-operative irradiation—employed to the extent to which it would be employed if it alone were depended upon to cure the cancer—is of definite value in inactivating the process. It is employed by the author in the obvious cases of cancer, followed by the radical operation. Post-operative irradiation is then used. Irradiation alone is employed in cases in which there is distant metastasis. In cases in which there is doubt as to existence of cancer, the procedure of local removal with the cautery with histopathologic study is instituted, and, if cancer is found, the radical amputation is done, followed by post-operative irradiation. In cases of breast cancer sterilization by irradiation is advocated for those women who are still menstruating.

W. R. BROOKSHER, M.D.

Near Distance Roentgen Irradiation of Skin Cancer. J. Wendlberger. *Strahlentherapie*, **67**, 51-60, January, 1940.

The author has treated 50 cases of carcinoma of the skin with near distance radiation as advocated by Chaoul. He gives two exposures every day and administers 500 r in the morning and the same dose in the afternoon for five or six days. Technic: 55 kv., 7 cm. F.S.D., 227 r/min., H.V.L. in Cu, 0.04 mm. In all

cases there was a definite effect of the radiation on the tumors. During an observation period of up to three years, 90 per cent showed primary healing. In basal-cell carcinoma which had received up to 5,000 r, the respective figure was 100 per cent. The author stresses the fact that even advanced cases show remarkable response to this type of treatment and believes that near distance roentgen radiation can successfully compete with radium therapy.

ERNST A. POHLE, M.D., Ph.D.

CELLS, DIVISION

Radiations Emitted by Living Organisms. Otto Glasser. *Cleveland Clin. Quart.*, 7, 15-18, January, 1940.

In order to understand mitogenic radiation, Glasser has made a thorough study of the work done by Gurwitsch and repeated some of the experiments, using the method of Baron. It has been demonstrated that the wave length is in the region of 2,000 Å. U., and the radiation is supposed to be a function of abnormal cell division, for which reason this radiation is important in the early detection of cancer.

The present studies on the whole have failed to confirm the contentions of Gurwitsch and his co-workers. However, Glasser is not completely satisfied with his experiments and intends to continue his studies in mitogenic radiation.

JOHN B. MCANENY, M.D.

THE CHEST

Notes on Penetrating Chest Wounds. F. G. Thomson. *British Med. Jour.*, 1, 44-46, Jan. 13, 1940.

The author gives a review of 600 cases of penetrating chest wounds treated at base hospitals in 1917 and 1918. Certain facts are pointed out which should be of interest to all who may come in contact with such patients. Of the 600 cases, 238 had complications, 72.8 per cent of which consisted of simple and infected hemothorax and pneumothorax, the latter being in the minority. It is pointed out that simple hemothorax is not an indication for exploration unless the fusion of blood is large enough to cause respiratory embarrassment. In all these simple cases the prognosis is eminently good. Cases of infected hemothorax merit evacuation of any foreign body which may be present and drainage of the pleural cavity as in the usual case of empyema.

Various devices to promote asepsis and encourage reflation of the lung are described. Use of a heavy drain tube to the skin is strongly condemned. The fresh air treatment as applied to influenza seemed very satisfactory. Mention is made of the system of early closure of penetrating chest wounds. Statistics given, however, do not indicate the advisability of this procedure.

Q. B. CORAY, M.D.

CONTRAST MEDIA

Intraventricular Use of Lipiodol in the Diagnosis of Cerebral Tumors. Yves Piette. *Zentralbl. f. Neurochirurgie*, February, 1939, No. 1, as abstracted with illustrations in *Australian and New Zealand Jour. Surg.*, 11, 321, 322, January, 1940.

The author describes the technic employed in 600 ventriculographies in the neurosurgical service of Prof. Manuel Balado, of Buenos Aires.

After pointing out that the invention of pneumoventriculography by Dandy, in 1918, has cleared away one of the principal obstacles to the advance of neurosurgery, by providing a means of precise localization, the author describes certain of the defects inherent in the employment of air for this procedure. The difficulty of visualizing the third ventricle, the insufficient contrast, and the escape of air from the ventricles sometimes disappoint the surgeon when a certain localizing diagnosis may have been reasonably anticipated.

Lipiodol, employed by Balado for ten years, produced no untoward results. On the other hand, many problems have been resolved which were incapable of solution by air injection. Perfect contrast is obtained, and no immediate severe reactions are noted. Occasionally, some days after the procedure, the patient may complain of pain in the legs, along the sciatic distribution. This is a common sequel to the use of lipiodol in the spinal canal.

The operation of ventricular puncture is performed with the patient lying prone. One trephine opening is made in the occipital region, the posterior horns of the lateral ventricle are tapped and the fluid pressure is measured. Enough fluid is withdrawn until the pressure is normal, and then 1 c.c. of lipiodol is injected. Alternate aspirations of 1 c.c. of fluid and the injection of 1 c.c. of lipiodol are continued until 4 c.c. have been introduced. This technic produces a better dispersion of the oily substance. Four exposures are made with the patient in the following positions: postero-anterior (forehead on the plate); lateral, with inclination of the head at 45°; the same position, five minutes later; fronto-occipital, with flexion of the head at 45°.

The films are taken at five-minute intervals, the heavy lipiodol passing into the most dependent parts of the ventricular system. The first position shows the frontal horns, sometimes the temporal horns and the third ventricle. Views of the aqueduct of Sylvius and the fourth ventricle are obtained in the third position, and, finally, a good view of the third ventricle is obtained in the fourth exposure. The interpretation of the films requires some experience, but the author claims that the four plates enable the investigator to piece together the outlines of the whole ventricular system. The illustrations which accompany the article speak for themselves.

This method would appear to offer certain advantages in cases in which a perfect view of the third ventricle and the aqueduct and the fourth ventricle is desirable.

SIMON POLLACK, M.D.

THE CRANIUM

Tuberculosis of the Flat Bones of the Vault of the Skull. George L. Beatty and C. A. Russell. *Jour. Bone and Joint Surg.*, **22**, 207-210, January, 1940.

Since less than 250 cases of tuberculosis of the cranial vault are reported in the literature, it is thought profitable to present this case. The lesion is almost always secondary to a lesion in the cervical lymph glands, lungs, or another bone. It is generally blood-borne and localizes in the diploe usually of the frontal or parietal bone. The process first extends to the inner table and later perforates the outer table. Sequestration may be present and cold abscess may form in the soft parts with subsequent fistula formation. The characteristic roentgen finding is a punched-out defect, definitely circumscribed by normal bone.

JOHN B. MCANENY, M.D.

DOSAGE

The Energy Measurement of Roentgen Rays. E. Császár. *Strahlentherapie*, **67**, 522, 1940.

In this third part of his paper dealing with the same subject (see *Strahlentherapie*, **67**, 322, 1940) the author discusses first the definition of the dose and the units used. He then relates the measurements of the dose for homogeneous radiation, the determination of the dose in water and in air as carried out with his specially designed instrument. The same measurements were done with inhomogeneous irradiation. Comparison of his so-called *roentgenometer* and a large ionization chamber showed satisfactory agreement. His apparatus is, therefore, not only suitable for determination of intensity and dose, but also for the calibration of small ionization chambers.

ERNST A. POHLE, M.D., Ph.D.

DYSTROPHY

Hypophysodystrophy with Diabetes Insipidus. Leandre Cervera and R. Torres-Carreras. *Strahlentherapie*, **67**, 339-346, March, 1940.

The authors relate the history of a 17-year-old male who had had diabetes insipidus since childhood and suffered also from Froehlich's syndrome (dystrophia adiposogenitalis). Roentgen examination of the skull showed a normal sella turcica. They decided to give x-ray therapy a trial and by exposing a total of six different fields administered a total dose of 1,050 r during a two-month period. Technic: 180 kv., 0.5 mm. Cu + 2 mm. Al, 35 cm. F.S.D. Within six months there was remarkable improvement; most striking were the normal development of male characteristics, including the reduction in size of the formerly large breasts. At the time of the writing of the report the man could be considered as cured; he was working then as a mechanic.

ERNST A. POHLE, M.D., Ph.D.

RADIOLOGY

THE ESOPHAGUS

The Roentgenological Diagnosis of Sideropenic Dysphagia (Plummer-Vinson's Syndrome). Jan Waldenström and Sven Roland Kjellberg. *Acta Radiol.*, **20**, 618-638, December, 1939.

Four reasons should, according to the authors, stimulate the interest of both roentgenologist and clinician with regard to this little known and hitherto largely neglected disease: (1) its very frequent occurrence which, in the authors' opinion, characterizes it as the most common affection of the hypopharynx and esophagus; (2) the good therapeutic results entirely dependent on a correct diagnosis; (3) its probably important rôle in the etiology of cancer of the mouth and throat, and (4) its specific x-ray signs.

Roentgenographically a special technic for the visualization of the hypopharynx and the upper portion of the esophagus is indispensable. Thick barium mixtures, serial roentgenograms, and exact timing by means of previous fluoroscopic studies are employed for this purpose. The most common site of the lesion is in the upper esophagus just below the level of the cricoid cartilage. As a rule, one or, more rarely, several barium-filling defects may be noted. These defects are thin (from 0.5 to 1.5 mm.) but often 5 or 6 mm. long, thus giving the appearance of a thin membrane. In most cases, the changes are best seen in the lateral view. This appearance is confirmed by gastroscopy which frequently shows a thin semilunar membrane on the anterior esophageal wall stretching toward the lateral areas. In advanced cases this change may result in a circular fold of the esophageal wall. Sometimes a bulb-like enlargement of hypopharynx can be demonstrated. A cuff-like stricture below the membrane is probably caused by infiltration of the esophageal wall. It may closely resemble carcinoma and may render the differential diagnosis extremely difficult.

The administration of iron in sufficient doses quickly relieves the esophageal symptoms but in invertebrate cases frequently only a partial improvement of the severe dysphagia may be obtained. In the latter cases the roentgenograms usually show a typical well marked stricture and a fold of mucous membrane. It must be noted that the x-ray appearance during treatment does not always improve at the same rate and to the same extent as the clinical signs, and the characteristic x-ray phenomena may persist after complete disappearance of the subjective symptoms. Cases of the disease without anemia have also been reported.

The observations and conclusions of the authors are based on a material of 54 cases seen at the hospitals of the University of Upsala during a four-year period.

ERNST A. SCHMIDT, M.D.

THE FEMUR

The Importance of Accurate Roentgenography and Interpretation in Femoral-neck Fractures Treated by Internal Fixation. Don King, Edward Leef, and

C. K. Terwilliger. *Jour. Bone and Joint Surg.*, **22**, 168-170, January, 1940.

This short and pointed communication demonstrates the importance of accurate roentgenograms to show the position of the fixation nail in fractures of the femoral neck. Two series of films are reproduced to show that although the nail may appear to have entered the femoral head, it really lies anteriorly or posteriorly. Even films made in "flexed-thigh position" to obtain a lateral view are not reliable because the center of rotation may be the nail, which will appear to be within the head fragment, while in reality it is not. No preferred procedure is suggested.

JOHN B. MCANENY, M.D.

FRACTURES

Dislocation of the Inferior Radio-ulnar Joint as a Complication of Fracture of the Radius. Geoffrey Hyman and F. R. R. Martin. *British Jour. Surg.*, **27**, 481-491, January, 1940.

Dislocations of the inferior radio-ulnar joint forming a component of a severe Colles' fracture are common and well recognized. Dislocation is present when there is a complete separation of the head of the ulna from the articular surface of the radius, as seen on a lateral roentgenograph of the wrist. Dislocation of the head of the ulna is anterior or posterior, and some distal displacement occurs in most cases. Disorganization of the inferior radio-ulnar joint always takes place and is most commonly due to a rupture of the triangular fibrocartilage. In all cases rupture of the ulna collateral ligament or fracture of the tip of the styloid process of the ulna must occur. The authors describe 25 cases which they divide into three groups according to mechanical factors involved. The prognosis is good except in the case of older patients (average age 55 years) in whom traumatic arthritic changes occur.

MAX CLIMAN, M.D.

Treatment of Fractured Femur at the Site of the Casualty. F. V. Chavasse. *British Med. Jour.*, **1**, 25, Jan. 6, 1940.

The subject discussed is one which, though not now important to medical men of the United States, may become all too important in the near future. The author discusses a simple method of transporting cases of fractured femur from the battlefield to a place of first aid or more effective treatment. The apparatus used is a simple army stretcher plus certain straps, bandages, or any other similar material which may be at hand. The patient is carefully placed on the stretcher; his feet are drawn well toward the foot end and securely fixed there by means of straps running over the handles. The stretcher and the patient are then raised until almost perpendicular so that the patient is literally hanging by his feet. After a few minutes in this position the muscles become tired and the fragments assume a more normal position with consequent decrease in pain. Before lowering the stretcher, countertraction

is effected by passing a strong strap between the legs and over the groin on the side of injury and fastening this tightly to the head end of the stretcher. The journey from the site of injury may then be undertaken without undue pain or shock to the victim.

Q. B. CORAY, M.D.

Clay-shoveler's Fracture. R. D. McKellar Hall. *Jour. Bone and Joint Surg.*, **22**, 63-75, January, 1940.

The term "clay-shoveler's fracture" is given to the fracture of the spinous process of any one or several of the vertebrae from the sixth cervical to the third thoracic. The fracture line is usually in the narrowest part of the spinous process, about one-half to three-fourths of an inch from its end.

The causative force may be direct but is usually the result of muscular pull caused by a sudden jerk while using a shovel to throw clay from a ditch to the bank overhead, or from a sudden jerk used to dislodge clay that is sticking to the shovel. The muscles involved are the rhomboids and trapezius.

The patient complains of pain between the scapulae just to one side of the midline, which is exaggerated by motion of the shoulder, and there is weakness of the arm.

Roentgenographically, the fracture is usually well demonstrated with lateral views of the lower cervical and upper thoracic spine. In some patients antero-posterior stereoscopic views may be necessary. Thirteen case reports are presented and reproductions of films showing the fracture are included.

JOHN B. MCANENY, M.D.

HEART AND VASCULAR SYSTEM

Metastatic Tumors of the Heart: Report of Two Cases Diagnosed Clinically. J. C. Hsiung, C. Szutu, C. K. Hsieh, and V. T. Lieu. *Chinese Med. Jour.*, **57**, 1-10, January, 1940.

"Tumors of the heart and pericardium, whether primary or secondary, are rare, and the diagnosis usually is made at the time of autopsy." Such is the opinion of the authors of this article after a review of the literature. They report two new cases diagnosed during life; one was proven at autopsy, the other, in which postmortem was refused, presented a very suggestive clinical as well as therapeutic history. The lesion was metastatic in both instances.

The roentgenologic signs consisted of enlargement of the cardiac shadow due to pleural effusion. The effusion diminished in both cases after radiation.

A. MAYORAL, M.D.

THE INTESTINES

Regional Ileitis. S. F. Marshall. *New England Jour. Med.*, **222**, 375-382, March 7, 1940.

Regional ileitis is one of many names given to an inflammatory granulomatous disease of the bowel frequently seen in the ileocecal region, but that may be found almost anywhere along the bowel. The causa-

tive agent is unknown, but fistula formation is a common finding. The symptomatology may resemble appendicitis, usually of the chronic type, and the patient may be operated upon, with removal of the appendix, but the real trouble may be overlooked. Later, a fistula may appear.

Diagnosis is often made by roentgen examination. Barium enema may show involvement of the cecum and terminal ileum. Examination by the barium meal, four, five, six, and ten hours after ingestion, may show constriction of the bowel in one or several places, sometimes the string sign, and occasionally fistulous tracts.

Several reproductions of barium designs in regional ileitis are presented. The surgical aspect of the condition is well discussed.

JOHN B. MCANENY, M.D.

THE JAWS

Tuberculosis of the Mandible. C. M. Meng. *Jour. Bone and Joint Surg.*, **22**, 17-27, January, 1940.

Meng reviews the cases of tuberculosis of the mandible seen at the Peiping Union Medical College Hospital, and has discovered 14 cases occurring in the past seventeen and one-half years. Of these, eight were seen in the past two and one-half years, leading to the belief that the condition is becoming more readily recognized. Males and females are affected with equal frequency. The age range is from four to forty-eight years.

The majority of the patients were poor, undernourished, and had associated pulmonary lesions. The onset is insidious and indefinite although other osseous lesions may be present.

Roentgenographically, slight or extensive changes may be seen, with rarefaction and necrosis evident and scanty or absent involucrum. Sequestra are frequently observed. Fracture may occur. Probably the most characteristic features are the absence of involucrum and the presence of active tuberculosis elsewhere, especially in bone.

JOHN B. MCANENY, M.D.

The Results of Irradiation of Malignant Growths of the Maxillary Region, with Special Attention to Ophthalmologic Problems. H. T. Schreus and F. K. Leydecker. *München. med. Wchnschr.*, **87**, 62-64, Jan. 19, 1940.

Advanced cases of neoplasms of the maxillary and ethmoid regions were submitted to irradiation. The technic involved a minimum tumor dose of 3,000 r and, in most cases, 4,000 r or more by a fractional dose administration. A 10 × 10 cm. lateral field and an anterior field from 4.5 × 6 to 6 × 8 cm. were employed. While lead shields were used over the eyeball whenever practical, the necessity for covering the entire tumor led to the direct irradiation of the eye in many cases. In this group, only two cases of mild keratitis and two of cataract occurred. In the entire series, 17 of 48 cases were alive 3 years; 9 of 23, 5 years; 3 of 8, 8 years, and none over 8 years. If the series is broken down into carcinomas and sarcomas, of the former 8 of 32 lived

3 years; 1 of 12, 5 years; none over 5 years; while of the latter, 9 of 16 lived 3 years; 8 of 11, 5 years, and 3 of 5, 8 years. These results show a definite superiority in the sarcoma group, and the authors conclude that patients with sarcoma should have the benefit of primary irradiation, while those with carcinoma may properly be first treated by surgical or electrosurgical procedures. In conclusion, the authors state that the results of irradiation are as good as those of surgery insofar as cure is concerned, and that the damage done, especially to the eye, is usually less. Combined irradiation employing both x-ray and radium merits preference.

LEWIS G. JACOBS, M.D.

LEUKEMIA

The Relationship between Sarcoma and Leukemia. W. Rathscheck. *Strahlentherapie*, **67**, 139-142, January, 1940.

The author reports the history of a patient who had a sarcoma of the mesenterium, histologically proved, which disappeared completely after roentgen therapy. Four weeks after the first treatment the patient developed an acute lymphatic leukemia from which he died. The author concludes that in view of this observation there must exist a definite relationship between the two diseases.

ERNST A. POHLE, M.D., Ph.D.

Uremia Following X-ray Therapy in Leukemia. Dudley Merrill. *New England Jour. Med.*, **222**, 94-97, Jan. 18, 1940.

Within a period of five years, three patients died of uremia following x-ray therapy for leukemia. This fact prompted Merrill to investigate the matter more thoroughly. Jugenburg and Tschotschia have written extensively on the subject and have concluded that the increased uric acid content of the blood is due to destruction of the nuclei of the white cells and that the blood uric acid level is a measure of the destructive process. Impaired kidney function is usually present and it is suggested that the right kidney be irradiated first so as not to mobilize too much uric acid by coincidentally irradiating the spleen with the left kidney.

Kidney function tests and blood chemistry should be done before irradiation of leukemic patients. Diet should be low in purine bodies. Alkalies and cincophen should be administered.

JOHN B. MCANENY, M.D.

LYMPH NODES

The Roentgen Diagnosis and Therapy of Retropharyngeal Adenitis. R. Rhett Rathbone. *Am. Jour. Roentgenol. and Rad. Ther.*, **43**, 25-28, January, 1940.

Retropharyngeal adenitis and abscess are common to the first year of life and rare after the third year.

In early life the number of nodes in this space varies from three to ten; in the adult from one to two. These drain the nasal accessory sinuses, nasal fossæ, pharynx,

larynx, and middle ear. In infants and young children the retropharyngeal space at the level of the second cervical vertebrae is never more than 11 mm. during inspiration. The retrotracheal space varies with age, being not more than 18 mm. up to one year, not over 16 mm. from one to two years, and not over 14 mm. after the age of two.

Röntgen therapy was given to 17 of 20 cases diagnosed as diseased. The procedure was 125 kv.p., 5 ma., 12 in. distance, 5 mm. Al, with a daily dose of 75 r, in air, for infants up to one year and 100 r for children between the ages of one and five years. One of three 15 X 15-cm. areas (anterior, right lateral, and left lateral) is treated on alternate days until each receives two treatments. In these fields are included the sinuses, mastoids, retropharyngeal space, and the entire upper respiratory tract.

In all, the swelling disappeared, but not in less than two weeks. The obstructive symptoms usually disappeared after the second treatment. None went on to suppuration.

S. M. ATKINS, M.D.

OSTEOCHONDRITIS

An Unusual Shoulder Lesion. Edwin N. Cleaves. *Jour. Bone and Joint Surg.*, **22**, 182-184, January, 1940.

This is a case report of a 17-year-old boy who was roentgenographed after an injury to his right shoulder. It is demonstrated that the apophysis of the acromial process of the scapula showed an osteochondritis and that the other shoulder showed the same changes. After 16 months the apophyses were still irregular and dense but showed progress toward the appearance of normal bone. The epiphyseal line was still partly open.

JOHN B. MCANENY, M.D.

OSTEOMYELITIS

Syphilitic Osteomyelitis. H. A. Thompson and A. Mayoral. *Jour. Bone and Joint Surg.*, **22**, 203-206, January, 1940.

This case report describes the various and different types of osseous lesions found in syphilis. The skull showed extensive osteoperiosteal changes with marked bone sclerosis accompanied by bone rarefaction of the upper vertebrae. There is thickening of the external table of the posterior portion of the skull. There were marked osteoperiosteal changes in the iliacs, sternum, right scapula, and a localized area of marked periosteal change in the upper half of the right femur.

The diagnosis is based on the diversity and widespread distribution of the lesions.

JOHN B. MCANENY, M.D.

THE OVARY

Röntgen Diagnosis of Dermoid Cysts of the Ovary in the Absence of Calcification. Samuel A. Robins and George White. *Am. Jour. Roentgenol. and Rad. Ther.*, **43**, 30-34, January, 1940.

The roentgen diagnosis of dermoid cysts of the ovary,

which constitute nearly 20 per cent of ovarian tumors, is usually based on the presence of teeth or other calcified shadows. This calcification is reported by one pathologist as occurring in 18 per cent of cases and by another in 49 per cent. In 6 of 22 patients in which no calcification was present, new signs were noted which are believed to be constant in dermoid cysts. These signs were: a rounded or ovoid mass of decreased density, regular in its contour, located in the pelvis and usually presenting a banded mottled appearance. Its border is sharply delineated from the surrounding tissue by a thin ring of increased density. This entire picture is constant in repeated examinations.

S. M. ATKINS, M.D.

PARALYSIS

Röntgen Rays in the Treatment of Progressive Paralysis. F. Bering. *Strahlentherapie*, **67**, 173-184, March, 1940.

The author relates his experience with the treatment of progressive paralysis by x-rays as observed in a series of 15 cases. He exposed four fields, left and right temporal, frontal and occipital, administering 220 r per area at intervals of eight days. The total dose effective in the brain amounted to approximately 80 per cent H.E.D. Technic: 185 kv., 0.5 mm. Cu, 30 cm. F.S.D. The treatment caused temporary epilation; in all patients the hair grew back again. One patient died after the treatment, apparently because of too high a dose; a second one died because the disease was already in too advanced a stage. All others were symptomatically improved. Very definite were the changes in the spinal fluid; serologic examination showed, above all, a disappearance of the lymphocytes. Some of the cases were observed for as long as 13 months. If the improvements noted are permanent, then x-ray therapy of progressive paralysis can, in the author's opinion, compete successfully with malaria treatment.

ERNST A. POHLE, M.D., Ph.D.

THE PENIS

Radium Therapy of Erythroplasia Penis. Juraj Körbler. *Strahlentherapie*, **67**, 61, 62, January, 1940.

Erythroplasia penis is a rare disease; it is considered a precancerous lesion of unknown etiology, the treatment of which is very difficult. The author saw two cases which he treated by means of radium screens filtered through from 0.5 mm. to 1 mm. Pt, applied in contact for a total dose of from 110 to 190 mg.-hr. Although a permanent cure could not be obtained, the treatment was of sufficient temporary benefit to recommend the use of radium in this lesion.

ERNST A. POHLE, M.D., Ph.D.

The Clinical Aspect and Radium Therapy of Induratio Penis Plastica. A. Vonessen. *Strahlentherapie*, **67**, 63-68, January, 1940.

The author saw 25 cases of induratio penis plastica during the period from 1931 to 1939; they were treated

by radium molds which had been constructed in the same manner as shingles are placed on a roof. At intervals of from two and one-half to three months a total dose of from 600 to 800 r was administered over the involved area. Some patients received as much as 8,000 r during a period of one and one-half years. Electric short wave therapy applied preceding the radium application seemed to enhance the therapeutic effect. The response was satisfactory in all cases, especially in regard to the functional disturbances.

ERNST A. POHLE, M.D., Ph.D.

RADIATION

The Influence of the Time Factor on the Effect of Alpha Rays. Ferdinand Hercik and Rudolf Machek. *Strahlentherapie*, **67**, 100-109, January, 1940.

The authors studied the influence of the time factor on the effect of alpha rays emitted by polonium on the epidermal tissue of *Allium cepa*. The intensity range as determined by a Geiger counter varied from 1 to 2,650. With intensities of from $9 \times$ to 43×10^6 alpha per mm.² per minute, no influence of the time factor could be detected. However, below and above these intensities there was a definite effect of the time factor; higher intensities had a stronger effect.

ERNST A. POHLE, M.D., Ph.D.

Roentgen "Layer" Irradiation (Soft and Near Distance Radiation), with Remarks Regarding Technic and Nomenclature. H. T. Schreus. *Strahlentherapie*, **67**, 39-50, January, 1940.

The author relates his experience in the treatment of superficial malignancies by means of roentgen rays applied at short focal skin distances. He proposes the treatment of "layer irradiation" because the effect of the radiation is intended to be limited to a superficial layer of tissue, thus preventing unnecessary exposure of the normal cells in deeper layers. By proper regulation of distance and penetration this goal can usually be attained. Some statistics are quoted to illustrate the author's contentions, based on 141 cases treated at his clinic.

ERNST A. POHLE, M.D., Ph.D.

The Pendulum Irradiation with Moving and Stationary Port of Entry. Eberhard Günsel. *Strahlentherapie*, **67**, 286-292, March, 1940.

The author advocates irradiation by means of a rotating tube because a better depth dose is obtained and at the same time the skin receives less irradiation. This can be further improved by moving the irradiated area also. While this has been acknowledged to hold for deep-seated lesions, the method can be employed to advantage in superficial malignancies, especially if only one single port can be used. The author demonstrated this contention experimentally by exposing to x-rays films embedded in a wax phantom. Curves are also shown, to illustrate the percentage depth dose in the

central ray obtained in a rice phantom for an immobilized and a rotating tube

ERNST A. POHLE, M.D., Ph.D.

RADIUM

A New Technic of Treatment of Carcinoma of the Cervix Uteri by Combining X-ray and Radium. James Z. Walker. *British Jour. Radiol.*, **13**, 1-24, January, 1940.

Because of the various manifestations of cancer of the cervix no standard method of treatment can be devised. Because of the free lymphatic drainage of the upper vagina and the uterus there is also danger of early extension. For this reason the whole volume of the true pelvis should be irradiated. Radium alone is doomed to failure in the earliest cases, as it is not possible to radiate adequately the lateral portions of the true pelvis without gross over-irradiation of the uterus and vagina. The distal parts must be dealt with by x-ray.

Uniform distribution throughout the tumor-bearing area is necessary. This dose must equal the minimum lethal dose for the tumor. In common methods of treatment, sufficient attention is not given to uniform adequate dosage.

Vaginal and uterine applicators are described and the method of placing for various types of lesions is given. X-ray therapy is given to four anteroposterior and four postero-anterior ports. The mid-line area corresponding to the areas treated with radium applicators is shielded with lead. The x-ray ports are lateral to this area. One-half the x-ray dose is given, then half of the radium dosage, then the remaining x-ray, and, finally, the rest of the radium. The total time of treatment is one month.

Details of the dosage and distribution are given by means of diagrams and table.

SYDNEY J. HAWLEY, M.D.

Radium Therapy of Lupus of the Mucosa. H. Loeffell. *Strahlentherapie*, **67**, 335-338, March, 1940.

The author relates his experience in the treatment of lupus of mucous membranes by radium, with special reference to the technic. Applicators are described; it is simple for lesions in the nose because the radium screen can be placed *in situ* without additional apparatus. A curved sound introduced through the nose is suitable for placing radium in the nasopharynx. In mouth lesions molds of dental compound are prepared. As a rule, 70 mg.-hr. per sq. cm. of diseased mucous membrane is given; the filter is 1 mm. brass. During the period between 1925 and 1938, 253 patients were treated by radium; in 49 instances the treatment had to be repeated because of a recurrence. Of the 196 cured patients, 164 were treated by radium exclusively. With the exception of 47, all patients have been under observation for five years or longer. It is concluded that radium therapy of lupus of the mucous membrane in nose, mouth, pharynx, and nasopharynx can be recommended.

ERNST A. POHLE, M.D., Ph.D.

ROENTGEN-RAY EFFECTS

The Different Effect of Ultra-violet and Roentgen Rays on Proteins. J. G. Heeren and Otto Seuberling. *Strahlentherapie*, **67**, 130-135, January, 1940.

The authors studied the effect of ultra-violet rays and roentgen rays on proteins. X-ray doses of from 5 to 50 H.E.D. were applied; 1 H.E.D. corresponded to 550 r (in air), produced at 180 kv. In addition to that, Grenz rays were used in some experiments produced at 10 kv. and delivering from 12,500 to 100,000 r (in air). Although ultra-violet rays separated sulphide and disulphide groups from the proteins in blood serum, roentgen rays even in such high doses did not produce a similar effect.

ERNST A. POHLE, M.D., Ph.D.

Studies Regarding the Effect of X-rays Applied with Different Methods on the Bone Marrow and its Cell Constituents, Also a Contribution to the Problem of the Time Factor. R. Bauer. *Strahlentherapie*, **67**, 424, 1940.

After a brief review of the literature regarding the effect of x-rays on bone marrow, the author relates the results of his own experiments carried out on rabbits. The femur was chosen for the tests. Three different intensities were used: 32 r/min., 154 r/min., and also 7.5 r/min. (185 to 195 kv., 0.5 mm. Cu). The doses varied from 50 to 9,000 r. The histologic findings in the bone marrow after irradiation are described in detail and numerous photomicrograms are appended. Simultaneously the changes in the irradiated skin and in the blood count were recorded. It appeared that the bone marrow, similar to the testicle, shows a more marked effect after fractionated treatment as compared with the same total dose given in one sitting. The reverse holds true for the skin. In order to sterilize the bone marrow, doses were required which produced epilation in the overlying skin. Comparing the effect of fractionating and protracting, the author comes to the conclusion that fractionating the dose is more important. The best effect of irradiation can be obtained if the "rhythm" of the exposures is correctly chosen. In the blood count a relative lymphopenia was observed although the exposure was carefully limited to the femur. This can perhaps be explained by a distant effect of irradiation on the centers where lymphocytes are formed.

ERNST A. POHLE, M.D., Ph.D.

SARCOMA

Treatment of Osteogenic Sarcoma. Albert B. Ferguson. *Jour. Bone and Joint Surg.*, **22**, 92-96, January, 1940.

From the first 400 cases of osteogenic sarcoma in the Registry of Bone Sarcoma, Ferguson selected 258 cases because of their complete data and definite diagnosis. From a thorough study of these he finds that late ampu-

tation (after six months following diagnosis) gives a higher percentage of five-year cures than does early amputation. Radiation before amputation improved the results of early amputation as did also excision before amputation.

The theory proposed for the better results following late amputation as compared with early amputation is as follows: All during the presence of the growth, tumor cells are being given off into the blood stream but they are rendered innoxious by the body and kept under control; however, should amputation be added to the already existing difficulties, the body can no longer control these metastatic fragments.

The suggested procedure in osteogenic sarcoma is to delay amputation for six months, awaiting a period of lessened metastatic activity. This time is well utilized by irradiation of the tumor, later excision of the primary growth, and, six months after diagnosis, amputation of the limb.

JOHN B. MCANENY, M.D.

THE SHOULDER JOINT

Arthrography and Roentgenography in Ruptures of the Tendons of the Shoulder Joint. Knut Lindblom. *Acta Radiol.*, **20**, 548-562, December, 1939.

Pathogenesis of Ruptures of the Tendon Aponeurosis of the Shoulder Joint. Knut Lindblom. *Acta Radiol.*, **20**, 563-577, December, 1939.

In the first of his articles the author describes different roentgenographic positions which allow the definite visualization of the various structures of the shoulder joint. The technic calls for a Lysholm skull table with Bucky diaphragm, as well as for the injection of a contrast medium (35 per cent perabrodil) into the joint. In this way, highly descriptive arthrograms were obtained in 51 cases of rupture of the supraspinatus and infraspinatus portions of the tendon aponeurosis, in 5 cases of rupture of the subscapular portion, and in 11 cases of rupture of the long biceps tendon. The method appears far superior to the usual technics without contrast medium and in which we have to rely largely on late or secondary bone changes (erosion, osteophytes, attrition, calcification, etc.).

In the second article the author discusses the pathogenesis of these ruptures of the tendon aponeurosis. For this purpose he executed quite interesting investigations with regard to the changes in the structure, the vascular system, and the tensility of the tendon aponeurosis; then, with regard to the age of the patient, his occupation, the relation between age and extent of the lesion, the connection with right- and left-handedness, the type of trauma, and, finally, the traumatic and non-traumatic complications. According to Lindblom, ruptures in the tendon aponeurosis of the shoulder joint never arise through attrition but are caused by one or more distinct traumas or, in exceptional cases, by severe destructive processes encountered in certain tendinous changes due to age.

ERNST A. SCHMIDT, M.D.

THE SKIN

The Sensitizing Effects of Tar Preparations on the Skin during Exposure to Ultra-violet and Grenz Rays. Lothar Peukert and Hans Koehler. *Strahlentherapie*, **67**, 266-285, March, 1940.

The authors studied the sensitizing action of a number of tar products on human skin. The reaction to ultra-violet rays as emitted by a quartz mercury vapor lamp was increased if tar had been applied to the exposed area beforehand. Studies with filtered ultra-violet light showed that the sensitization is most pronounced for radiation of approximately 3,200-4,050 Å. Grenz-ray reactions were likewise more pronounced if the exposed area had previously been treated by tar applications. Tests showed that coal tar in a layer of about 0.05 mm. absorbs 68.5 per cent of wave length 4,360, 97 per cent of 3,660, and almost 100 per cent of wave length 3,340 Å.

ERNST A. POHLE, M.D., Ph.D.

Finsen Therapy and its Rôle in the Rational Treatment of Lupus Vulgaris. Svend Lomholt. *Strahlentherapie*, **67**, 3-22, January, 1940.

In the Finsen Institute, in Copenhagen, 196 patients with lupus were treated during the period between 1924 and 1936; 15 of these discontinued treatments before finishing the prescribed series. Of the remaining patients, 96.7 per cent were free from symptoms at the time of writing the report. A series of illustrations showing the remarkable results obtained are shown in the paper.

ERNST A. POHLE, M.D., Ph.D.

SPINAL CANAL

The Sedimentation of Oil by Myelography and its Diagnostic Significance. Folke Knutsson. *Acta Radiol.*, **20**, 537-547, December, 1939.

As the position and movement (sedimentation) of oily substances are greatly influenced by physical properties (specific gravity, consistency, etc.) of the substances employed, the significance of these factors for the x-ray diagnosis must not be overlooked. The surface tension of the oils produces characteristic meniscus signs which are without clinical importance and should be differentiated from pathologic filling defects. The intense contrast (density) of the oils frequently precludes the visualization of small lesions. The author stresses the fact that the typical filling defect in myelography, caused by protrusion of the disc, is "exclusively due to that part of the prominence that rises above the fluid level. The contour of the defect is caused by the borderline between the oil surface and the prominence." This observation explains the necessity of obtaining roentgenograms under both horizontal and vertical direction of the rays since certain protrusion which may remain hidden in one projection—"submerged rocks," as the author expresses it—may definitely visualize in other positions.

ERNST A. SCHMIDT, M.D.

SPINAL CORD

The Bone Lesions Accompanying Cervical Spinal Cord Injuries: An End-result Study of 76 Cases. Donald Munro and Walter Wegner. *New England Jour. Med.*, **222**, 167-173, Feb. 1, 1940.

In a review of 76 cases of acute cervical injuries in which both bone and cord damage was present, 45 per cent were found to have died in the hospital. Dislocation is the commonest lesion and occurs between the first and second vertebrae most frequently, but also between the fourth, fifth, and sixth vertebrae. Nearly all these injuries are due to indirect violence and the mechanism is flexion of the neck with acute angulation of the cervical spine, permitting the articular facets of the upper vertebra to override those of the lower. The intervertebral disc and ligaments are torn. Sometimes fracture accompanies the dislocation.

Diagnosis is confirmed by x-ray studies which are difficult to make because of the frequent accompaniment of cord injury.

Traction in extension is the best method of treatment and operation, if done, is delayed for some time. All patients are put on tidal drainage.

JOHN B. MCANENY, M.D.

THE SPINE

Spondylolisthesis: Observations on its Development, Progression, and Genesis. Harold H. Hitchcock. *Jour. Bone and Joint Surg.*, **22**, 1-16, January, 1940.

In order to demonstrate that spondylolisthesis occurs in the absence of trauma and that definite progression of the slipping occurs, both of which features have been denied, Hitchcock presents three cases showing progression, one of which shows a break in the pedicle at the age of four years, before trauma or slipping has occurred. Progress of the slipping is accompanied by evidence of thinning of the intervertebral disc, which can be found anterior to the body of the lower vertebra, and about the displaced disc an osteophytic process may develop.

It is accepted that the lesion results from an interruption in the continuity of the neural arch; it occurs in approximately 5 or 6 per cent of patients, and is of about equal frequency in males and females.

To investigate the possibility of congenital origin of the defect, the spines of 90 fetuses from six weeks of intra-uterine life to term were examined. Ossification is seen to develop from three centers: one for the vertebral body and one for each side of the neural arch. Each vertebra is formed in cartilage and the ossification begins about the third month, spreading peripherally from all centers. At birth, union between the pedicles and body has not occurred, the isthmus still being cartilaginous. Herein seems to lie the potentiality for separation which results in spondylolisthesis later in life.

A number of stillborn children, aged from eight months to term and infant cadavers up to ten months

post-natal, were examined following hyperflexion of the spine. It was found possible with little force, to rupture the neural arch in the cartilaginous portion. Most of these fractures were bilateral, but by varying the procedure fracture on one side only could be produced. These findings strengthen the traumatic theory of the genesis of spondyloschisis. Trauma at birth or shortly thereafter could fracture the cartilaginous pedicle, accounting for the findings of union by fibrous tissue, or the development of a pseudo-arthrosis, as reported by various observers.

JOHN B. MCANENY, M.D.

Compression Fractures of the Vertebral Bodies Following Induced and "Idiopathic" Convulsions. George E. Reed and Travis E. Dancey. *Canadian Med. Assn. Jour.*, 42, 38, 39, January, 1940.

The authors point out that compression fractures of the vertebral bodies may occur in a variety of circumstances in which forceful muscular flexion is brought about, be it "idiopathic," as in case of a major epileptic attack, or due to the introduction of a foreign substance such as metrazol or insulin. A comparison of the compression fractures of patients with "idiopathic" epileptic seizures and patients receiving metrazol or insulin shows striking resemblance. In 72 adult epileptic patients, similar fracture deformities were observed in 34.2 per cent, while in 86 patients who received metrazol or insulin, 31.4 per cent showed compression fractures of the thoracic vertebral bodies. This type of injury occurs particularly in the mid-thoracic portion of the spine and usually more than one vertebral body is affected. The generalized severe muscular action produces extension of the cervical and lumbar spine with flexion and angulation of the thoracic portion.

M. L. CONNELLY, M.D.

Tetanus and Lesions of the Spine in Childhood. Harry F. Dietrich, Rolla G. Karshner, and Steele F. Stewart. *Jour. Bone and Joint Surg.*, 22, 43-54, January, 1940.

From 1921 to 1939, there were 28 cases of tetanus seen at the Los Angeles Children's Hospital. If these cases be divided into two groups, by the year 1933 it is seen that the mortality rate has dropped from 80 to 8 per cent. Death occurred promptly following a severe reaction after the administration of intravenous or intrathecal antitoxin. Since 1933, less intravenous antitoxin and no intrathecal antitoxin has been given. It is suggested that the antitoxin be given intramuscularly and about the wound; and if it be given intravenously, it should be accompanied by adrenalin. Definite sedation should be produced by amytal, avertin, paraldehyde, or seconal.

Roentgenologically, the important feature in this study is the lesions found in the spine resulting from the convulsions of tetanus. The increased percentage of recoveries in later years makes these findings of importance.

The spine shows characteristically compression fractures of the mid-thoracic vertebral bodies, usually the fifth, sixth, or seventh, or all the bodies from the fourth to the ninth. The compression may be limited to the anterior portion or it may involve the whole body. Usually the body is wedge-shaped, and the density of it is increased. The intervertebral space is unchanged. There is no change in the remaining portions of the vertebra. The reduction in the height of the vertebrae is usually greater than in kyphosis dorsalis juvenilis, and the region affected is a higher level. Differentiation from other conditions is easily made.

JOHN B. MCANENY, M.D.

Epiphysitis of the Spine. Louis Nathan and John G. Kuhns. *Jour. Bone and Joint Surg.*, 22, 55-62, January, 1940.

This is a study of 75 patients with epiphysitis of the vertebrae in which the age ranged from eight and one-half years to puberty. There is a familial history in many cases. Faulty posture was a constant finding; scoliosis and associated spinal deformities were common. Laboratory findings were all normal.

Diagnosis can be made only with the aid of roentgenograms. The changes consist in irregularity of the upper and lower surfaces of the vertebral bodies, especially along the anterior margins. Instead of the normal triangular opaque areas of the epiphyses there were irregular, frayed, or spotty areas of calcification. Vertebral decalcification was an inconstant early finding, but the bodies were well calcified when examined a year later. So-called Schmorl's islands were seen in 21 patients. In the healing stage the vertebral surfaces became smooth. The treatment is discussed.

JOHN B. MCANENY, M.D.

THE THYROID

Thyroid Tumor of the Humerus without Demonstrable Goiter: Report of a Case with Biological Assay of the Tumor. Frank D. Dickson, Rex L. Diveley, and Ferdinand C. Helwig. *Jour. Bone and Joint Surg.*, 22, 151-156, January, 1940.

Following a review of early discovery of so-called "benign metastasizing goiter" and a statement of the various theories offered to explain its occurrence, a case report is presented in detail.

A 54-year-old woman was seen, with a large tumor of the upper end of the left humerus two weeks after an injury. The roentgenogram of the shoulder showed a destructive lesion in the humerus; other bones showed no lesion. Biopsy showed a thyroid adenoma that was thought to have no cancerous characteristics. The thyroid gland was neither nodular nor enlarged.

The limb was removed by disarticulation at the shoulder joint. Again, there was no evidence of malignancy in the tumor. Three years later the patient died, after showing metastatic lesions in the lungs and, even though autopsy was not permitted, an incision at the

site of amputation showed a recurrence of the lesion which now gave definite evidence of cancer.

JOHN B. MCANENY, M.D.

TUBERCULOSIS, PULMONARY

The Prognosis of Infantile Tuberculosis. Clement A. Smith and Winifred De Lacey. *New England Jour. Med.*, **222**, 213-217, Feb. 8, 1940.

In a previous study it was demonstrated that there is a high infant mortality from tuberculosis in the first two years of life, death usually being due to miliary tuberculosis, while in older children death is due to tuberculous meningitis not associated with miliary disease.

In a 15-year period, 339 infants with tuberculosis were seen. Of this number 191 (56 per cent) died in the hospital. Of the remaining patients, the records of 116 are available for study. In all but one of those who succumbed to their disease this event took place within one year of the diagnosis. Exclusive of tuberculous meningitis, death occurs in those showing miliary tuberculosis, parenchymal consolidation, diffuse congestion, and enlarged hilus in the chest film. No deaths occurred in those children showing calcification or no involvement in the chest roentgenogram.

Attention is called particularly to the acute nature of infantile tuberculosis and the improvement in prognosis, once the infant has survived the critical first year after discovery of the disease.

JOHN B. MCANENY, M.D.

TUMORS

Malignant Melanoma: A Statistical and Pathologic Review of 35 Cases. Laurence R. Taussig and Frances A. Torrey. *California and West. Med.*, **52**, 15-18, January, 1940.

The authors have reviewed 35 cases of malignant melanoma and present a discussion covering its classification, clinical findings, and treatment.

Of the 35 cases reported, seven have survived over a five-year period. In their discussion of treatment and prognosis, these writers state that they have no explanation as to why certain cases were apparently cured, and others terminated fatally. They did note that the patients who were cured presented localized lesions, and no evidence of metastasis. They believe that this disease may be cured if thoroughly removed early enough in its course either by radical excision or electro thermic means, at which time pathologic study does not enable the prognosis to be determined.

JAMES J. CLARK, M.D.

The Systemic and Indirect Effects of X-rays and Their Significance in the Treatment of Malignant Tumors. H. Bade. *Strahlentherapie*, **67**, 353, 1940.

The author reviews first our present knowledge as to

the systemic and indirect effect of x-rays. He covers clinical observations, the effect of x-rays on the bone marrow and the blood itself, chemical and physico-chemical changes in blood and serum after irradiation, the effect of x-rays on the metabolism, immunity and also observations in animal experiments, especially on tumor implants. An analysis of 3,497 case histories treated at the Surgical Clinic of the University of Kiel since 1912 for some malignancy revealed that no relationship existed apparently between the occurrence of metastases and preceding x-ray or radium therapy. Mice whose entire bodies were exposed to small doses did not show any increased resistance to tumor implants. Immunity was definitely decreased following general body exposure to 300 r. No difference could be detected in the growth of the tumor implant whether the tumor bed had been irradiated or not. Histologically there was no difference between irradiated and unirradiated areas. There was also no increased incidence of metastases in irradiated animals. No stimulation of the reticulo-endothelial cells was observed following exposure to 10 r. However, general body exposures to 300 r produced definite injury to the reticulo-endothelial system. It is concluded that the systemic effect of roentgen rays in treating malignant tumors is not material and that the direct effect of radiation on malignant cells is largely responsible for the effects observed.

ERNST A. POHLE, M.D., Ph.D.

Diagnosis and Treatment of Mediastinal Tumors. W. Lahm. *Strahlentherapie*, **67**, 185-204, March, 1940.

The author selected 12 illustrative case reports of patients with mediastinal tumors which he had observed during the period from 1932 to 1936. They were either Hodgkin's disease or lymphosarcoma. In establishing the differential diagnosis, he feels that leukocytosis and lymphopenia, accompanied by some anemia, are in favor of Hodgkin's disease. He recommends intensive x-ray therapy applied according to the fractional dose method with some protraction. Technic: from 200 to 300 r over the involved region, repeated every second or third day; total doses from 900 to 1,200 r, occasionally as high as 1,800 r. In mapping out the individual treatment plan the clinical picture must be carefully considered. The author observed a prolongation of life up to four and one-half years. Local recurrence can be avoided by giving sufficiently high doses; however, this does not stop the generalization of the involvement. Low leukocyte count in the beginning is considered a sign of poor prognosis; in the end stage the blood picture can sometimes change suddenly to that of an aleukemic leukemia with high lymphocytosis. Supplementary arsenic medication in connection with x-ray therapy is recommended.

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